

# CITY OF SANTEE

## REQUEST FOR BIDS



### SANTEE COMMUNITY CENTER CIP 2018-31

**RFB Issued | August 27, 2025**

**Pre-Bid Meeting | September 16, 2025 • 10:00 AM**

**Bid Opening | October 29, 2025 • 10:00 AM**

**Engineer's Estimate: \$18.5 Million**

**Time for Completion: 380 Working Days**





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## CITY OF SANTEE

### 00100 - NOTICE INVITING BIDS

The City of Santee ("City") will receive sealed bids for the Santee Community Center at the Office of the City Clerk, Santee City Hall, Building 3, 10601 Magnolia Avenue, Santee, California 92071, no later than 10:00 am on October 29, 2025, at which time or thereafter said bids will be opened and read aloud. Bids received after this time will be returned unopened. Bids shall be valid for 60 calendar days after the bid opening date.

The Engineer's estimate for the base bid is \$18,500,000.

Bids must be submitted on the City's Bid Forms.

The Contract Documents will be available for review and download on the City's website [www.cityofsanteeca.gov](http://www.cityofsanteeca.gov) under the "Bid Opportunities" link on the main page. Additionally, Contract Documents are available for review at the Office of the City Clerk, Building 3, Santee City Hall, 10601 Magnolia Avenue between the hours of 8:00am to 5:00pm Monday-Thursday and 8:00am to 1:00pm on Friday on non-City recognized holidays.

**SPECIAL NOTICE ABOUT COVID-19:** This project consists of essential work and will therefore proceed unless appropriate governmental authorities order the work to cease. By submitting a Bid for this work, Bidder agrees to proceed with the work as proposed and to execute the contract in the form provided. Any conditions, caveats, or force majeure notices submitted with Bidder's bid will not be accepted and may result in a determination that the bid is non-responsive. Any such conditions, caveats, or notices submitted after award may result in the forfeiture of Bidder's bid security and award to the next lowest bidder. Bidders shall comply with the requirements provided in the section titled, "COVID-19 Safety Measures," of the Special Conditions. The costs of adhering to and complying with such requirements, and any future updates thereto, shall be included in the Bidders' bid amount. Key prevention practices include, but are not limited to, physical distancing, face coverings, frequent handwashing, regular cleaning and disinfection, and training employees on preventing the spread of COVID-19.

To the extent required by section 20103.7 of the Public Contract Code, upon request from a contractor plan room service, electronic copies may be downloaded without fee at the City's website [www.cityofsanteeca.gov](http://www.cityofsanteeca.gov) under the "Bid Opportunities" link on the main page.

Bids must be accompanied by cash, a certified or cashier's check, or a Bid Bond in favor of the City in an amount not less than ten percent (10%) of the submitted Total Bid Price.

A NON-MANDATORY Pre-Bid Conference will be held on **September 16, 2025, at 10:00 AM, on site at the Cameron Family YMCA grass lawn located at 10123 Riverwalk Drive, Santee CA 92071**. It is recommended that all attendees review the contract documents in advance of the Pre-Bid Conference to familiarize themselves with the



project. Bidders may inspect the project site at any time during the bid between the hours of 7am to 7pm. Bids will be accepted from any bidder who did not attend the Pre-Bid Conference. Each prospective bidder shall register as a Plan Holder by providing notice to the City's contact person stated in Section 3 of the Information for Bidders. Prospective bidders shall provide the company name, contact person, phone number and email of the prospective bidder so that any notice related to the bid can be provided by the City to the prospective bidders.

Each bid shall be accompanied by the security referred to in the Contract Documents, the non-collusion declaration, the list of proposed subcontractors, and all additional documentation required by the Instructions to Bidders.

The successful bidder will be required to furnish the City with a Performance Bond equal to 100% of the successful bid, and a Payment Bond equal to 100% of the successful bid, prior to execution of the Contract. All bonds are to be secured from a surety that meets all of the State of California bonding requirements, as defined in Code of Civil Procedure Section 995.120, and is admitted by the State of California.

Pursuant to Public Contract Code Section 22300, the successful bidder may substitute certain securities for funds withheld by City to ensure their performance under the Contract.

The Director of Industrial Relations has determined the general prevailing rate of per diem wages in the locality in which this work is to be performed for each craft or type of worker needed to execute the Contract which will be awarded to the successful bidder, copies of which are on file and will be made available to any interested party upon request to Santee City Hall, Engineering Department, Building 3, Attn: Director of Engineering, 10601 Magnolia Avenue, Santee, California 92071, or online at <http://www.dir.ca.gov/dlsr>. A copy of these rates shall be posted by the successful bidder at the job site. The successful bidder and all subcontractor(s) under him, shall comply with all applicable Labor Code provisions, which include, but are not limited to the payment of not less than the required prevailing rates to all workers employed by them in the execution of the Contract, the employment of apprentices, the hours of labor and the debarment of contractors and subcontractors.

Pursuant to Labor Code sections 1725.5 and 1771.1, all contractors and subcontractors that wish to bid on, be listed in a bid proposal, or enter into a contract to perform public work must be registered with the Department of Industrial Relations. No bid will be accepted nor any contract entered into without proof of the contractor's and subcontractors' current registration with the Department of Industrial Relations to perform public work. If awarded a Contract, the Bidder and its subcontractors, of any tier, shall maintain active registration with the Department of Industrial Relations for the duration of the Project.

This Project is subject to compliance monitoring and enforcement by the Department of Industrial Relations. In bidding on this project, it shall be the Bidder's sole responsibility



to evaluate and include the cost of complying with all labor compliance requirements under this contract and applicable law in its bid.

Each bidder shall be a licensed contractor pursuant to the Business and Professions Code and shall be licensed in the following appropriate classification(s) of contractor's license(s), for the work bid upon, and must maintain the license(s) throughout the duration of the Contract: **General Engineering Contractor (Class A) or General Building Contractor (Class B).**

Pursuant to Public Contract Code Section 3400(b), if the City has made any findings designating certain materials, products, things, or services by specific brand or trade name, such findings and the materials, products, things, or services and their specific brand or trade names will be set forth in the Special Conditions.

Award of Contract: The City shall award the Contract for the Project to the lowest responsible bidder as determined from the Base Bid by the City. The City reserves the right to reject any or all bids or to waive any irregularities or informalities in any bids or in the bidding process.

For further information, contact Taylor Carrico, Assistant Engineer at [tcarrico@cityofsanteeca.gov](mailto:tcarrico@cityofsanteeca.gov).

Dated: August 27, 2025



## **CITY OF SANTEE**

### **00200 - INSTRUCTIONS TO BIDDERS**

#### **1. AVAILABILITY OF CONTRACT DOCUMENTS**

Bids must be submitted to the City on the Bid Forms which are a part of the Bid Package for the Project. Contract Documents, including plans, specifications, technical reports and other related documents are available for review and download at the City's website [www.cityofsanteeca.gov](http://www.cityofsanteeca.gov) located at the "Bid Opportunities" link on the main page. Copies are available for review at the Office of the City Clerk, Building 3, Santee City Hall, 10601 Magnolia Avenue between the hours of 8:00am to 5:00pm Monday-Thursday and 8:00am to 1:00pm on Friday on non-City recognized holidays.

The City shall also make the Contract Documents available for review in electronic form at one or more plan rooms at no charge, as required by Public Contract Code section 20103.7. The City does not assume any liability or responsibility based on any defective or incomplete copying, excerpting, scanning, faxing, downloading or printing of the Contract Documents.

Addenda, if any, issued during the bid period will be sent only to those contractors who requested to be placed on the City maintained plan holder's/bidder list. Failure to acknowledge Addenda may make a bid nonresponsive and ineligible for award of the Contract.

#### **2. EXAMINATION OF CONTRACT DOCUMENTS**

The City has made copies of the Contract Documents available, as indicated above. Bidders shall be solely responsible for examining the Project Site and the Contract Documents, including any Addenda issued during the bidding period, and for informing itself with respect to local labor availability, means of transportation, necessity for security, laws and codes, local permit requirements, wage scales, local tax structure, contractors' licensing requirements, availability of required insurance, and other factors that could affect the Work. Bidders are responsible for consulting the standards referenced in the Contract. Failure of Bidder to so examine and inform itself shall be at its sole risk, and no relief for error or omission will be given except as required under State law.

#### **3. INTERPRETATION OF CONTRACT DOCUMENTS**

Discrepancies in, and/or omissions from the Plans, Specifications or other Contract Documents or questions as to their meaning shall be immediately brought to the attention of the City by submission of a written request for an interpretation or correction to the City. Such submission, if any, must be sent to Taylor Carrico, Assistant Engineer by emailing to [tcarrico@cityofsanteeca.gov](mailto:tcarrico@cityofsanteeca.gov).

Any interpretation of the Contract Documents will be made only by written addenda duly issued and mailed or delivered to each person or firm who has purchased a set of Contract Documents. The City will not be responsible for any explanations or



interpretations provided in any other manner. No person is authorized to make any oral interpretation of any provision in the Contract Documents to any bidder, and no bidder should rely on any such oral interpretation.

Bids shall include complete compensation for all items of work to be performed under the Contract Documents.

#### **4. INSPECTION OF SITE; PRE-BID CONFERENCE AND SITE WALK**

Each prospective bidder is responsible for fully acquainting itself with the conditions of the Project Site (which may include more than one site), as well as those relating to the construction and labor of the Project, to fully understand the facilities, difficulties and restrictions which may impact the cost or effort required to complete the Project.

#### **5. ADDENDA**

The City reserves the right to revise the Contract Documents prior to the bid opening date. Revisions, if any, shall be made by Addenda. All addenda issued by the City shall be included in the bid and made part of the Contract Documents. Pursuant to Public Contract Code Section 4104.5, if the City issues an Addendum which includes material changes to the Project less than 72 hours prior to the deadline for submission of bids, the City will extend the deadline for submission of bids. The City may determine, in its sole discretion, whether an Addendum warrants postponement of the bid submission date. Each prospective bidder should register as a Plan Holder in accordance with the Notice Inviting Bids in order to ensure receipt of Addenda as they are issued. Please Note: Bidders are responsible for ensuring that they have received any and all Addenda by reviewing the posted Addenda on the City's website. To this end, each bidder should contact the City's representative stated in Section 3 to verify that they have received all Addenda issued, if any, prior to the bid opening. Failure to acknowledge receipt of all addenda may result in bid rejection.

#### **6. ALTERNATE BIDS**

If alternate bid items are called for in the Contract Documents, the lowest bid will be determined on the basis of the base bid only, unless otherwise specified in the Notice Inviting Bids. The time required for completion of the alternate bid items has been factored into the Contract Time and no additional time will be awarded for any of the alternate bid items. The City may elect to include one or more of the alternate bid items, or to otherwise remove certain work from the Project scope of work. Accordingly, each Bidder must ensure that each bid item contains a proportionate share of profit, overhead and other costs or expenses which will be incurred by the Bidder.

#### **7. COMPLETION OF BID FORMS**

Bids shall only be prepared using copies of the Bid Forms which are included in the Contract Documents. The use of substitute bid forms other than clear and correct photocopies of those provided by the City will not be permitted. Bids shall be executed by an authorized signatory as described in these Instructions to Bidders. In addition, Bidders shall fill in all blank spaces (including inserting "N/A" where applicable) and initial



all interlineations, alterations, or erasures to the Bid Forms. Bidders shall neither delete, modify, nor supplement the printed matter on the Bid Forms nor make substitutions thereon. USE OF BLACK OR BLUE INK, INDELIBLE PENCIL OR A TYPEWRITER IS REQUIRED. Deviations in the bid form may result in the bid being deemed non-responsive.

## **8. MODIFICATIONS OF BIDS**

Each Bidder shall submit its Bid in strict conformity with the requirements of the Contract Documents. Unauthorized additions, modifications, revisions, conditions, limitations, exclusions or provisions attached to a Bid may render it non-responsive and may cause its rejection. Bidders shall neither delete, modify, nor supplement the printed matter on the Bid Forms, nor make substitutions thereon. Oral, telephonic and electronic modifications will not be considered, unless the Notice Inviting Bids authorizes the submission of electronic bids and modifications thereto and such modifications are made in accordance with the Notice Inviting Bids.

## **9. DESIGNATION OF SUBCONTRACTORS**

Pursuant to State law, the Bidders must designate the name and location of each subcontractor who will perform work or render services for the Bidder in an amount that exceeds one-half of one percent (1/2%) of the Bidder's Total Bid Price, or \$10,000, whichever is greater, as well as the portion of work each such subcontractor will perform on the form provided herein by the City. No additional time will be provided to bidders to submit any of the requested information in the Designation of Subcontractor form.

## **10. LICENSING REQUIREMENTS**

Pursuant to Section 7028.15 of the Business and Professions Code and Section 3300 of the Public Contract Code, all bidders must possess proper licenses for performance of this Contract. Subcontractors must possess the appropriate licenses for each specialty subcontracted. Pursuant to Section 7028.5 of the Business and Professions Code, the City shall consider any bid submitted by a contractor not currently licensed in accordance with state law and pursuant to the requirements found in the Contract Documents to be nonresponsive, and the City shall reject the Bid. The City shall have the right to request, and Bidders shall provide within five (5) calendar days, evidence satisfactory to the City of all valid license(s) currently held by that Bidder and each of the Bidder's subcontractors, before awarding the Contract.

Notwithstanding anything contained herein, if the Work involves federal funds, the Contractor shall be properly licensed by the time the Contract is awarded, pursuant to the provisions of Public Contract Code section 20103.5.

## **11. SIGNING OF BIDS**

All Bids submitted shall be executed by the Bidder or its authorized representative. Bidders may be asked to provide evidence in the form of an authenticated resolution of its Board of Directors or a Power of Attorney evidencing the capacity of the person signing the Bid to bind the Bidder to each Bid and to any Contract arising therefrom.



If a Bidder is a joint venture or partnership, it may be asked to submit an authenticated Power of Attorney executed by each joint venturer or partner appointing and designating one of the joint venturers or partners as a management sponsor to execute the Bid on behalf of Bidder. Only that joint venturer or partner shall execute the Bid. The Power of Attorney shall also: (1) authorize that particular joint venturer or partner to act for and bind Bidder in all matters relating to the Bid; and (2) provide that each venturer or partner shall be jointly and severally liable for any and all of the duties and obligations of Bidder assumed under the Bid and under any Contract arising therefrom. The Bid shall be executed by the designated joint venturer or partner on behalf of the joint venture or partnership in its legal name.

## **12. BID GUARANTEE (BID BOND)**

Each bid shall be accompanied by: (a) cash; (b) a certified check made payable to the City; (c) a cashier's check made payable to the City; or (d) a bid bond payable to the City executed by the bidder as principal and surety as obligor in an amount not less than 10% of the maximum amount of the bid. Personal sureties and unregistered surety companies are unacceptable. The surety insurer shall be California admitted surety insurer, as defined in Code of Civil Procedure Section 995.120. The cash, check or bid bond shall be given as a guarantee that the bidder shall execute the Contract if it be awarded to the bidder, shall provide the payment and performance bonds and insurance certificates and endorsements as required herein within ten (10) calendar days after notification of the award of the Contract to the bidder. Failure to provide the required documents may result in forfeiture of the bidder's bid deposit or bond to the City and the City may award the Contract to the next lowest responsible bidder, or may call for new bids.

## **13. SUBMISSION OF SEALED BIDS**

Once the Bid and supporting documents have been completed and signed as set forth herein, they shall be placed, along with the Bid Guarantee and other required materials in an envelope, sealed, addressed and delivered or mailed, postage prepaid to the City at the place and to the attention of the person indicated in the Notice Inviting Bids. No oral or telephonic bids will be considered. No forms transmitted via the internet, e-mail, facsimile, or any other electronic means will be considered unless specifically authorized by City as provided herein. The envelope shall also contain the following in the lower left-hand corner thereof:

Bid of \_\_\_\_\_  
(Bidder's Name)  
for the Santee Community Center (CIP 2018-31) project. (Bidder's email address to confirm receipt of Bid)

Only where expressly permitted in the Notice Inviting Bids, may Bidders submit their bids via electronic transmission pursuant to Public Contract Code Sections 1600 and 1601. The acceptable method(s) of electronic transmission shall be stated in the Notice Inviting Bids. City reserves the right to not accept electronically transmitted bids where not specifically authorized in the Notice Inviting Bids, and may reject any bid not strictly



complying with City's designated methods for delivery.

#### **14.DELIVERY AND OPENING OF BIDS**

Bids will be received by the City at the address shown in the Notice Inviting Bids up to the date and time shown therein. The City will leave unopened any Bid received after the specified date and time, and any such unopened Bid will be returned to the Bidder. It is the Bidder's sole responsibility to ensure that its Bid is received as specified. Bids may be submitted earlier than the dates(s) and time(s) indicated.

Bids will be opened at the date and time stated in the Notice Inviting Bids, and the amount of each Bid will be read aloud and recorded. All Bidders may, if they desire, attend the opening of Bids. The City may, in its sole discretion, elect to postpone the opening of the submitted Bids. City reserves the right to reject any or all Bids and to waive any informality or irregularity in any Bid. In the event of a discrepancy between the written amount of the Bid Price and the numerical amount of the Bid Price, the written amount shall govern.

#### **15.WITHDRAWAL OF BID**

Prior to bid opening, a Bid may be withdrawn by the Bidder only by means of a written request signed by the Bidder or its properly authorized representative. Any request to withdraw a bid after bid opening must be made in accordance with Public Contract Code section 5100 et seq. and must be submitted in writing within five (5) working days, excluding Saturday, Sundays and State holidays, specifying in detail how the mistake was made.

#### **16.BASIS OF AWARD; BALANCED BIDS**

The City shall award the Contract to the lowest responsible Bidder submitting a responsive Bid. The City may reject any Bid which, in its opinion when compared to other bids received or to the City's internal estimates, does not accurately reflect the cost to perform the Work. The City may reject as non-responsive any bid which unevenly weights or allocates costs, including but not limited to overhead and profit to one or more particular bid items.

#### **17.DISQUALIFICATION OF BIDDERS; INTEREST IN MORE THAN ONE BID**

No bidder shall be allowed to make, submit or be interested in more than one bid. However, a person, firm, corporation or other entity that has submitted a subproposal to a bidder, or that has quoted prices of materials to a bidder, is not thereby disqualified from submitting a subproposal or quoting prices to other bidders submitting a bid to the City. No person, firm, corporation, or other entity may submit subproposal to a bidder, or quote prices of materials to a bidder, when also submitting a prime bid on the same Project.

#### **18.INSURANCE REQUIREMENTS**

The successful bidder shall procure the insurance in the form and in the amount specified in the Contract Documents.



## **19.AWARD PROCESS**

Once all Bids are opened and reviewed to determine the lowest responsive and responsible Bidder, the City may award the contract, or reject all bids. The apparent successful Bidder should begin to prepare the following documents: (1) the Performance Bond; (2) the Payment Bond; and (3) the required insurance certificates and endorsements. Once the City notifies the Bidder of the award, the Bidder will have ten (10) consecutive calendar days from the date of this notification to execute the Contract and supply the City with all of the required documents and certifications. Regardless whether the Bidder supplies the required documents and certifications in a timely manner, the Contract time will begin to run ten (10) calendar days from the date of the notification. Once the City receives all of the properly drafted and executed documents and certifications from the Bidder, the City shall issue a Notice to Proceed to that Bidder.

## **20.FILING OF BID PROTESTS**

Any bid protest relating to the form or content of the Bid or Contract Documents must be submitted in writing to the Office of the City Clerk, 10601 Magnolia Avenue, Santee, CA 92071 or via email at [clerk@cityofsantee.ca.gov](mailto:clerk@cityofsantee.ca.gov) at least ten (10) business days before the original date set for the bid opening. Any bidder who submits a bid without making a protest shall be deemed to have waived any objection to the form or content of the Bid or Contract Documents not previously stated in writing.

Submitted bids will be timely made available for review upon written request of any bidder.

Bidders may file a “protest” of a Bid with the City’s Director of Engineering. In order for a Bidder’s protest to be considered valid, the protest must:

- A. Be filed in writing not later than 5:00 pm on the fifth business day after the bid opening date;
- B. Clearly identify the specific irregularity or basis for the protest;
- C. Specify, in detail, the factual and legal grounds for the protest; and
- D. Include all relevant, supporting documentation with the protest at time of filing.
- E. If the protest does not meet all of these requirements, the City may reject it without further review.

If the protest is timely and complies with all of the above requirements, the City’s Director of Engineering, or other designated City staff member, shall review the protest, any response from the challenged bidder, and all other relevant information. Written response to the protestor will be provided by the City.

The procedure and time limits set forth in this section are mandatory and are the sole and exclusive remedy in the event of a bid protest. Failure to comply with these procedures shall constitute a failure to exhaust administrative remedies and a waiver of any right to further pursue the bid protest, including filing a Government Code Claim or legal proceedings.



## **21. WORKERS COMPENSATION**

Each bidder shall submit the Contractor's Certificate Regarding Workers' Compensation form.

## **22. RETENTION AND SUBSTITUTION OF SECURITY**

The Contract Documents call for monthly progress payments based upon the percentage of the work completed. The City will retain five percent (5%) of each progress payment as provided by the Contract Documents. At the request and expense of the successful Bidder, the City will substitute securities for the amount so retained in accordance with Public Contract Code Section 22300.

## **23. PREVAILING WAGES**

The City has obtained from the Director of the Department of Industrial Relations the general prevailing rate of per diem wages in the locality in which this work is to be performed for each craft or type of worker needed to execute the Contract. These rates may be obtained online at <http://www.dir.ca.gov/dlsr>. or may be reviewed at the Department of Engineering, 10601 Magnolia Avenue, Santee, CA 92071. Bidders are advised that a copy of these rates must be posted by the successful Bidder at the job site(s).

## **24. DEBARMENT OF CONTRACTORS AND SUBCONTRACTORS**

In accordance with the provisions of the Labor Code, contractors or subcontractors may not perform work on a public works project with a subcontractor who is ineligible to perform work on a public project pursuant to Section 1777.1 or Section 1777.7 of the Labor Code. Any contract on a public works project entered into between a contractor and a debarred subcontractor is void as a matter of law. A debarred subcontractor may not receive any public money for performing work as a subcontractor on a public works contract. Any public money that is paid to a debarred subcontractor by the Contractor for the Project shall be returned to the City. The Contractor shall be responsible for the payment of wages to workers of a debarred subcontractor who has been allowed to work on the Project.

## **25. IRAN CONTRACTING ACT CERTIFICATION**

Each bidder shall submit the certification required by the Iran Contracting Act of 2010, Public Contract Code section 2200 et seq. with its bid. The certification is included in the Contract Documents.

## **26. PUBLIC WORKS CONTRACTOR REGISTRATION CERTIFICATION**

Pursuant to Labor Code sections 1725.5 and 1771.1, all contractors and subcontractors that wish to bid on, be listed in a bid proposal, or enter into a contract to perform public work must be registered with the Department of Industrial Relations. No bid will be accepted nor any contract entered into without proof of the contractor's and subcontractors' current registration with the Department of Industrial Relations to perform



public work. If awarded a Contract, the Bidder and its subcontractors, of any tier, shall maintain active registration with the Department of Industrial Relations for the duration of the Project. To this end, Bidder shall sign and submit with its Bid the Public Works Contractor Registration Certification on the form provided, attesting to the facts contained therein. Failure to submit this form may render the Bid non-responsive. In addition, each Bidder shall provide the registration number for each listed subcontractor in the space provided in the Designation of Subcontractors Form.

## **27. PERFORMANCE BOND AND PAYMENT BOND REQUIREMENTS**

Within the time specified in the Contract Documents, the Bidder to whom a Contract is awarded shall deliver to the City four identical counterparts of the Performance Bond and Payment Bond in the form supplied by the City and included in the Contract Documents. Failure to do so may, in the sole discretion of City, result in the forfeiture of the Bid Guarantee. The surety supplying the bond must be an admitted surety insurer, as defined in Code of Civil Procedure Section 995.120, authorized to do business as such in the State of California and satisfactory to the City. The Performance Bond and the Payment Bond shall be for one hundred percent (100%) of the Total Bid Price.

## **28. REQUEST FOR SUBSTITUTIONS**

The successful bidder shall comply with the substitution request provisions set forth in the Special Conditions, including any deadlines for substitution requests **which may occur prior to the bid opening date.**

## **29. SELF PERFORMANCE**

The Contractor shall self-perform with its own organization, Contract work amounting to at least **Twenty Percent (20%)** of the Total Bid. For purpose of evaluation the percentage of work performed by Subcontractors, the cost of all equipment, supplies and materials used or installed on the project by Subcontractors shall be considered as part of work of the Subcontractors. This will apply even if the Contractor supplies and pays for some or all equipment, supplies or materials used by Subcontractor.

## **30. SALES AND OTHER APPLICABLE TAXES, PERMITS, LICENSES AND FEES**

Contractor and its subcontractors performing work under this Contract will be required to pay California sales tax and other applicable taxes, and to pay for permits, licenses and fees required by the agencies with authority in the jurisdiction in which the work will be located, unless otherwise expressly provided by the Contract Documents. Bidders shall include all applicable taxes and fees that are in effect or reasonably anticipated on the bid date in their bid price.

## **31. EXECUTION OF CONTRACT**

As required herein the Bidder to whom an award is made shall execute the Contract in the amount determined by the Contract Documents. The City may require appropriate evidence that the persons executing the Contract are duly empowered to do so.



**END OF INSTRUCTIONS TO BIDDERS**



## 00400 - BID FORM

NAME OF BIDDER: \_\_\_\_\_

The undersigned, hereby declares that we have carefully examined the location of the proposed Work, and have read and examined the Contract Documents, including all plans, specifications, attachments, special conditions and all addenda, if any, for the following Project:

SANTEE COMMUNITY CENTER (CIP 2018-31)

We hereby propose to furnish all labor, materials, equipment, tools, professional services, inspection services, permitting services, transportation, incidentals, temporary utilities and services, and to discharge all duties and obligations necessary and required to perform and complete the Project in strict accordance with the Contract Documents including all plans, specifications, attachments, special conditions and all addenda, if any, for the following TOTAL BID PRICE:

<b>BASE BID</b>	<b>BID PRICE (IN WRITTEN FORM)</b>	<b>BID PRICE (IN NUMBERS)</b>
TOTAL BID PRICE		

In case of discrepancy between the written price and the numerical price, the written piece shall prevail.

The estimated quantities for unit price items are for purposes of comparing bids only and the City makes no representation that the actual quantities of work performed will not vary from the estimates.

In case of discrepancy between the unit price and the line item cost set forth for a unit price item, the line item cost, calculated at the unit price multiplied by the estimated quantity, shall prevail and, shall be utilized as the basis for determining the lowest responsive, responsible bidder. However, if the amount set forth as a unit price is ambiguous, unintelligible or uncertain for any cause, or is omitted, or is the same amount as the entry in the "Line Item Cost" column, then the amount set forth in the "Line Item Cost" column for the item shall prevail and shall be divided by the estimated quantity for the item and the price thus obtained shall be the unit price. If any of the above discrepancies exist, the City may recalculate the bid price on the basis of the unit price and the bidder agrees to be bound by such recalculation. Final payment for unit price items shall be determined by the Engineer from measured quantities of work performed based upon the unit price.

The undersigned agrees that this Bid Form constitutes a firm offer to the City which cannot



be withdrawn for the number of calendar days indicated in the Notice Inviting Bids from and after the bid opening, or until a Contract for the Work is fully executed by the City and a third party, whichever is earlier.

The Contract duration shall commence on the date stated in the City's Notice to Proceed, and shall be completed by the Contractor in the time specified in the Contract Documents. In no case shall the Contractor commence construction prior to the date stated in the City's Notice to Proceed, or before providing the required bonds and evidence of insurance.

Bidder certifies that it is licensed in accordance with the law providing for the registration of Contractors, License No. \_\_\_\_\_, Expiration Date \_\_\_\_\_, class of license \_\_\_\_\_. If the bidder is a joint venture, each member of the joint venture must include the above information.

The undersigned acknowledges receipt, understanding and full consideration of the following addenda to the Contract Documents.

Addenda No. \_\_\_\_\_  
Addenda No. \_\_\_\_\_  
Addenda No. \_\_\_\_\_

1. Attached is the required bid security in the amount of not less than 10% of the Total Bid Price.
2. Attached is the fully executed Non-Collusion Declaration form.
3. Attached is the completed Designation of Subcontractors form.
4. Attached is the completed Bidder Information Form.
5. Attached is the completed Iran Contracting Act Certification.
6. Attached is the completed Contractor's Certificate Regarding Workers' Compensation form.
7. Attached is the completed Public Works Contractor Registration Certification form.

I hereby certify under penalty of perjury under the laws of the State of California that all of the information submitted in connection with this Bid and all of the representations made herein are true and correct.

Name of Bidder \_\_\_\_\_

Signature \_\_\_\_\_

Name and Title \_\_\_\_\_

Legal Address \_\_\_\_\_

\_\_\_\_\_



Telephone \_\_\_\_\_  
Number \_\_\_\_\_  
Dated \_\_\_\_\_



**00405 - CONTRACTOR'S CERTIFICATE REGARDING  
WORKERS' COMPENSATION**

I am aware of the provisions of Section 3700 of the Labor Code which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the work of this Contract.

Name of Bidder \_\_\_\_\_

Signature \_\_\_\_\_

Name \_\_\_\_\_

Title \_\_\_\_\_

Dated \_\_\_\_\_



## 00410 - BID BOND

The makers of this bond are, \_\_\_\_\_, as Principal, and \_\_\_\_\_, as Surety, and are held and firmly bound unto the City of Santee, hereinafter called the City, in the penal sum of TEN PERCENT (10%) OF THE TOTAL BID PRICE of the Principal submitted to CITY for the work described below, for the payment of which sum in lawful money of the United States, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH that whereas the Principal has submitted the accompanying bid dated \_\_\_\_\_, 20\_\_\_\_, for Santee Community Center (CIP 2018-31).

If the Principal does not withdraw its bid within the time specified in the Contract Documents; and if bid is rejected or, in the alternate, the Principal is awarded the Contract, signs the Contract and provides all documents to the City as required by the Contract Documents; then this obligation shall be null and void. Otherwise, this bond will remain in full force and effect and upon default of the Principal shall be forfeited to the City, it being expressly understood and agreed that the liability of the Surety for any and all default of the Principal shall be the amount of this obligation as herein stated, as liquidated damages.

Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract Documents shall affect its obligation under this bond, and Surety does hereby waive notice of any such changes.

In the event a lawsuit is brought upon this bond by the City and judgment is recovered, the Surety shall pay all litigation expenses incurred by the City in such suit, in addition to the sum set forth above, including reasonable attorneys' fees, court costs, expert witness fees and expenses.

IN WITNESS WHEREOF, the above-bound parties have executed this instrument under their several seals this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_, the name and corporate seal of each corporation.

(Bid Bond Continued on next page)



**BID BOND CONTINUED**

(Corporate Seal)

\_\_\_\_\_  
Principal

By \_\_\_\_\_

Title \_\_\_\_\_  
\_\_\_\_\_

(Corporate Seal)

Surety

By \_\_\_\_\_

Attorney-in-Fact

(Attach Attorney-in-Fact Certificate)

Title \_\_\_\_\_

Address of Surety:  
\_\_\_\_\_  
\_\_\_\_\_



## Notary Acknowledgment

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

STATE OF CALIFORNIA

COUNTY OF \_\_\_\_\_

On \_\_\_\_\_, 20\_\_\_\_, before me, \_\_\_\_\_, Notary Public, personally

appeared \_\_\_\_\_, who proved to me on the basis of satisfactory

evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Signature of Notary Public

### OPTIONAL

*Though the information below is not required by law, it may prove valuable to persons relying on the document and could prevent fraudulent removal and reattachment of this form to another document.*

#### CAPACITY CLAIMED BY SIGNER

#### DESCRIPTION OF ATTACHED DOCUMENT

☐ Individual

☐ Corporate Officer

Title(s)

Title or Type of Document

☐ Partner(s)

☐ Limited

☐ General

Number of Pages

☐ Attorney-In-Fact

☐ Trustee(s)

☐ Guardian/Conservator

☐ Other:

Date of Document

Signer is representing:

Name Of Person(s) Or Entity(ies)

Signer(s) Other Than Named Above

**NOTE:** A copy of the Power-of-Attorney to local representatives of the bonding company must be attached hereto.



## 00420 - NON-COLLUSION DECLARATION

TO BE EXECUTED BY BIDDER AND SUBMITTED WITH BID

The undersigned declares:

I am the \_\_\_\_\_ of \_\_\_\_\_, the party making the foregoing bid.

The bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation. The bid is genuine and not collusive or sham. The bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid. The bidder has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or to refrain from bidding. The bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other bidder. All statements contained in the bid are true. The bidder has not directly or indirectly, submitted their bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, to any corporation, partnership, company, association, organization, bid depository, or to any member or agent thereof to effectuate a collusive or sham bid, and has not paid, and will not pay, any person or entity for such purpose.

Any person executing this declaration on behalf of a bidder that is a corporation, partnership, joint venture, limited liability company, limited liability partnership, or any other entity, hereby represents that he or she has full power to execute, and does execute, this declaration on behalf of the bidder.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this declaration is executed on \_\_\_\_\_(date), at \_\_\_\_\_(city), \_\_\_\_\_(state).

(Signature)

(Print Name)

(Print Title)

(Date)



## 00430 - CONTRACTOR INFORMATION AND EXPERIENCE FORM

### A. INFORMATION ABOUT BIDDER

Failure to complete all information may render your bid non-responsive. [\*\*Indicate not applicable ("N/A") where appropriate.\*\*]

**NOTE:** Where Bidder is a joint venture, pages shall be duplicated and information provided for all parties to the joint venture.

1.0 Name of Bidder: \_\_\_\_\_

2.0 Type, if Entity: \_\_\_\_\_

3.0 Bidder Address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

4.0 How many years has Bidder's organization been in business as a Contractor?

\_\_\_\_\_

5.0 How many years has Bidder's organization been in business under its present name?

\_\_\_\_\_

5.1 Under what other or former names has Bidder's organization operated?:

\_\_\_\_\_

6.0 If Bidder's organization is a corporation, answer the following:

6.1 Date of Incorporation: \_\_\_\_\_

6.2 State of Incorporation: \_\_\_\_\_

6.3 President's Name: \_\_\_\_\_



6.4 Vice-President's Name(s):

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6.5 Secretary's Name: \_\_\_\_\_

6.6 Treasurer's Name: \_\_\_\_\_

7.0 If an individual or a partnership, answer the following:

7.1 Date of Organization: \_\_\_\_\_

7.2 Name of address of all partners (state whether general or limited partnership):

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8.0 If other than a corporation or partnership, describe organization and name principals:

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9.0 List other states in which Bidder's organization is legally qualified to do business.

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10.0 What type of work does the Bidder normally perform with its own forces?

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11.0 Has Bidder ever failed to complete any work awarded to it? If so, note when, where, and why:

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12.0 Within the last five years, has any officer or partner of Bidder's organization ever been an officer or partner of another organization when it failed to complete a contract? If so, attach a separate sheet of explanation:

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13.0 List Trade References:

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14.0 List Bank References (Bank and Branch Address):

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15.0 Name of Bonding Company and Name and Address of Agent:

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16.0 Name of Insurance Company(ies) and Name, Address, and Phone Numbers of Agent(s):



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## B. LIST OF CURRENT PROJECTS (Backlog)

[\*\*Duplicate Page if needed for listing additional current projects.\*\*]

<b>Project</b>	<b>Description of Bidder's Work</b>	<b>Completion Date</b>	<b>Project Owner's Contact Name</b>	<b>Phone No.</b>	<b>Cost of Bidder's Work</b>



### C. LIST OF COMPLETED PROJECTS - LAST THREE YEARS

[\*\*Duplicate Page if needed for listing additional completed projects.\*\*]

Please include only those projects which are similar enough to demonstrate Bidder's ability to perform the required Work.

<b>Project Client</b>	<b>Description of Bidder's Work</b>	<b>Period of Performance</b>	<b>Project Owner's Contact Name</b>	<b>Project Owner's Phone No.</b>	<b>Cost of Bidder's Work</b>



## D. EXPERIENCE AND TECHNICAL QUALIFICATIONS QUESTIONNAIRE

### *Personnel:*

The Bidder shall identify the key personnel to be assigned to this project in a management, construction supervision or engineering capacity.

1. List each person's job title, name and percent of time to be allocated to this project:

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2. Summarize each person's specialized education:

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3. List each person's years of construction experience relevant to the project:

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4. Summarize such experience:

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Bidder agrees that personnel named in this Bid will remain on this Project in their designated capacities until completion of all relevant Work, unless substituted by personnel of equivalent experience and qualifications approved in advance by the City.



***Additional Bidder's Statements:***

If the Bidder feels that there is additional information which has not been included in the questionnaire above, and which would contribute to the qualification review, it may add that information in a statement here or on an attached sheet, appropriately marked:

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**E. VERIFICATION AND EXECUTION**

These Bid Forms shall be executed only by a duly authorized official of the Bidder:

I declare under penalty of perjury under the laws of the State of California that the foregoing information is true and correct:

Name of Bidder\_\_\_\_\_

Signature\_\_\_\_\_

Name\_\_\_\_\_

Title\_\_\_\_\_

Dated\_\_\_\_\_

**END OF BIDDER INFORMATION AND EXPERIENCE FORM**



### 00440 - LIST OF SUBCONTRACTORS FORM

In compliance with the Subletting and Subcontracting Fair Practices Act of the Public Contract Code of the State of California, each bidder shall set forth below: (a) the name and the location of the place of business, (b) the California contractor license number and (c) the DIR public works contractor registration number, and (d) the portion of the work which will be done by each subcontractor who will perform work or labor or render service to the Contractor in or about the construction of the work in an amount in excess of one-half of one percent (1/2%) of the Contractor's Total Bid Price. Notwithstanding the foregoing, if the work involves streets and highways, then the Contractor shall list each subcontractor who will perform work or labor or render service to Contractor in or about the work in an amount in excess of one-half of one percent (1/2%) of the Contractor's Total Bid Price or \$10,000, whichever is greater. No additional time shall be granted to provide the below requested information.

If no subcontractor is specified, for a portion of the work, or if more than one subcontractor is specified for the same portion of Work, to be performed under the Contract in excess of one-half of one percent (1/2%) of the Contractor's Total Bid Price or \$10,000, whichever is greater if the work involves streets or highways, then the Contractor shall be deemed to have agreed that it is fully qualified to perform that Work, and that it shall perform that portion itself.

**The Contractor shall perform with its own organization, Contract Work amounting to at least 20% of the Total Bid.**

<b>Work to be done by Subcontractor</b>	<b>Name of Subcontractor</b>	<b>Location of Business</b>	<b>CSLB License No.</b>	<b>DIR Registration Number</b>	<b>% of the Work</b>



<b>Work to be done by Subcontractor</b>	<b>Name of Subcontractor</b>	<b>Location of Business</b>	<b>CSLB License No.</b>	<b>DIR Registration Number</b>	<b>% of the Work</b>

Name of Bidder\_\_\_\_\_

Signature\_\_\_\_\_

Name and Title\_\_\_\_\_

Dated\_\_\_\_\_



## 00450 - IRAN CONTRACTING ACT CERTIFICATION

### (Public Contract Code section 2200 et seq.)

As required by California Public Contract Code section 2204, the Contractor certifies subject to penalty for perjury that the option checked below relating to the Contractor's status in regard to the Iran Contracting Act of 2010 (Public Contract Code section 2200 et seq.) is true and correct:

☐ The Contractor is not:

(i) identified on the current list of persons and entities engaging in investment activities in Iran prepared by the California Department of General Services in accordance with subdivision (b) of Public Contract Code section 2203; or

(ii) a financial institution that extends, for 45 days or more, credit in the amount of \$20,000,000 or more to any other person or entity identified on the current list of persons and entities engaging in investment activities in Iran prepared by the California Department of General Services in accordance with subdivision (b) of Public Contract Code section 2203, if the person or entity uses or will use the credit to provide goods or services in the energy sector in Iran.

☐ City has exempted the Contractor from the requirements of the Iran Contracting Act of 2010 after making a public finding that, absent the exemption, Agency will be unable to obtain the goods and/or services to be provided pursuant to the Contract.

☐ The amount of the Contract payable to the Contractor for the Work does not exceed \$1,000,000.

(Signed) \_\_\_\_\_

(Print Title) \_\_\_\_\_

(Firm) \_\_\_\_\_

(Date) \_\_\_\_\_

**NOTE:** In accordance with Public Contract Code section 2205, false certification of this form shall be reported to the California Attorney General and may result in civil penalties equal to the greater of \$250,000 or twice the Contract Price, termination of the Contract and/or ineligibility to bid on contracts for three years.



## 00460 - PUBLIC WORKS CONTRACTOR REGISTRATION CERTIFICATION

Pursuant to Labor Code sections 1725.5 and 1771.1, all contractors and subcontractors that wish to bid on, be listed in a bid proposal, or enter into a contract to perform public work must be registered with the Department of Industrial Relations. See <http://www.dir.ca.gov/Public-Works/PublicWorks.html> for additional information.

No bid will be accepted nor any contract entered into without proof of the contractor's and subcontractors' current registration with the Department of Industrial Relations to perform public work.

Bidder hereby certifies that it is aware of the registration requirements set forth in Labor Code sections 1725.5 and 1771.1 and is currently registered as a contractor with the Department of Industrial Relations.

Name of Bidder: \_\_\_\_\_

DIR Registration Number: \_\_\_\_\_

DIR Registration Expiration: \_\_\_\_\_

Bidder further acknowledges:

1. Bidder shall maintain a current DIR registration for the duration of the project.
2. Bidder shall include the requirements of Labor Code sections 1725.5 and 1771.1 in its contract with subcontractors and ensure that all subcontractors are registered at the time of bid opening and maintain registration status for the duration of the project.
3. Failure to submit this form or comply with any of the above requirements may result in a finding that the bid is non-responsive.

Name of Bidder \_\_\_\_\_

Signature \_\_\_\_\_

Name and Title \_\_\_\_\_

Dated \_\_\_\_\_



## 00500 - CONTRACT

THIS CONTRACT is made on \_\_\_\_\_, 20\_\_\_\_, in the County of San Diego, State of California, by and between the CITY OF SANTEE, hereinafter called City, and \_\_\_\_\_, hereinafter called Contractor. The City and the Contractor for the considerations stated herein agree as follows:

### ARTICLE 1.

**SCOPE OF WORK.** The Contractor shall perform all Work within the time stipulated in the Contract and shall provide all labor, materials, equipment, tools, utility services, and transportation to complete all of the Work required in strict compliance with the Contract Documents as specified in Article 5 below for the following Project:

Santee Community Center (CIP 2018-31)

The Contractor and its surety shall be liable to the City for any damages arising as a result of the Contractor's failure to comply with this obligation.

### ARTICLE 2.

**TIME FOR COMPLETION.** Time is of the essence in the performance of the Work. The Work shall be commenced on the date stated in the City's Notice to Proceed. The Contractor shall complete all Work required by the Contract Documents within **380 calendar days** from the commencement date stated in the Notice to Proceed, hereinafter the Contract Time. By its signature hereunder, Contractor agrees the Contract Time for completion set forth above is adequate and reasonable to complete the Work.

### ARTICLE 3.

**CONTRACT PRICE.** The City shall pay to the Contractor as full compensation for the performance of the Contract, subject to any additions or deductions as provided in the Contract Documents, and including all applicable taxes and costs, the sum of \_\_\_\_\_ Dollars (\$\_\_\_\_\_), hereinafter the Contract Price. Payment shall be made as set forth in the General Conditions.

### ARTICLE 4.

**LIQUIDATED DAMAGES.** The Contractor acknowledges that the City will sustain actual damages for each and every day completion of the Project is delayed beyond the Contract Time. Because of the nature of the Project, it would be impracticable or extremely difficult to determine the City's actual damages. Accordingly, as provided in Government Code section 53069.85, it is agreed that the Contractor will pay the City the sum of **\$7,000.00** for each and every calendar day of delay in completing the Work beyond the time prescribed in the Contract Documents for finishing the Work, as Liquidated Damages and not as a penalty or forfeiture. In the event the Liquidated Damages are not paid, the Contractor agrees the City may deduct that amount from any money due or that may become due the Contractor under the Contract. This Article does not affect the City's



rights to other damages or remedies specified in the Contract Documents or allowed by law.

Should Contractor be inexcusably delayed in the performance of the Work, City may deduct Liquidated Damages based on its estimate of when Contractor will achieve Final Completion or other milestones. City need not wait until Final Completion to withhold Liquidated Damages from Contractor.

Liquidated Damages are not a penalty but an agreed upon estimate of the actual damages that would be sustained by the City for delay, including but not limited to loss of revenue, inconvenience to the City and the public, and increased Project administration expenses, such as extra inspection, construction management, staff time and architectural and engineering expenses. Liquidated Damages do not include actual damages the City incurs on account of claims by third parties against the City on account of any delay.

Should money due or to become due to the Contractor be insufficient to cover Liquidated Damages or other offsets due, then Contractor forthwith shall pay the remainder of the Assessed liquidated damages to City.

#### **ARTICLE 5.**

**COMPONENT PARTS OF THE CONTRACT.** The “Contract Documents” include the following:

- Notice Inviting Bids
- Instructions to Bidders
- Bid Form
- Contractor’s Certificate Regarding Workers’ Compensation
- Bid Bond
- List of Subcontractors Form
- Information Required of Bidders
- Non-Collusion Declaration form
- Contract
- Performance Bond
- Payment Bond
- Environmental Documents and Approvals
- General Conditions
- Special Conditions
- Technical Specifications
- Addenda (if any)
- Plans and Drawings
- Approved and fully executed change orders
- Any other documents contained in or incorporated into the Contract

The Contractor shall complete the Work in strict accordance with all of the Contract Documents.



All of the Contract Documents are intended to be complementary. Work required by one of the Contract Documents and not by others shall be done as if required by all. This Contract shall supersede any prior agreement of the parties.

**ARTICLE 6.**

**PROVISIONS REQUIRED BY LAW.** Each and every provision of law required to be included in these Contract Documents shall be deemed to be included in these Contract Documents. The Contractor shall comply with all requirements of applicable federal, state and local laws, rules and regulations, including but not limited to, the provisions of the California Labor Code and Public Contract Code applicable to this Project.

**ARTICLE 7.**

**INDEMNIFICATION.** Contractor shall provide indemnification as set forth in the General Conditions.

**ARTICLE 8.**

**PREVAILING WAGES.** Contractor shall be required to pay the prevailing rate of wages in accordance with the Labor Code which such rates shall be made available at Director of Engineering, City of Santee, 10601 Magnolia Avenue, Santee, CA 92071 or may be obtained online at <http://www.dir.ca.gov/dlsr> and which must be posted at the job site.

IN WITNESS WHEREOF, this Contract has been duly executed by the above-named parties, on the day and year above written.

**CONTRACTOR**

**CITY OF SANTEE**

By:

\_\_\_\_\_

Name and Title:

\_\_\_\_\_

License No.

\_\_\_\_\_

By

\_\_\_\_\_

Gary Halbert  
Interim City Manager

**APPROVED AS TO FORM**

By:

\_\_\_\_\_

Shawn Hagerty  
City Attorney of the City of Santee



## 00610 - PERFORMANCE BOND

KNOW ALL PERSONS BY THESE PRESENTS:

THAT WHEREAS, CITY OF SANTEE (hereinafter referred to as "City"), by action taken or a resolution passed on \_\_\_\_\_, 20\_\_\_\_, has awarded to \_\_\_\_\_, (hereinafter referred to as the "Contractor") an agreement for construction of Santee Community Center (CIP 2018-31) (hereinafter referred to as the "Project").

WHEREAS, the work to be performed by the Contractor is more particularly set forth in the Contract Documents for the Project dated \_\_\_\_\_, (hereinafter referred to as "Contract Documents"), the terms and conditions of which are expressly incorporated herein by reference; and

WHEREAS, the Contractor is required by said Contract Documents to perform the terms thereof and to furnish a bond for the faithful performance of said Contract Documents.

NOW, \_\_\_\_\_, THEREFORE, \_\_\_\_\_, we, \_\_\_\_\_, the undersigned Contractor, and \_\_\_\_\_ as Surety, a corporation organized and duly authorized to transact business under the laws of the State of California, are held and firmly bound unto the City in the sum of \_\_\_\_\_ Dollars, (\$ \_\_\_\_\_), said sum being not less than one hundred percent (100%) of the total amount of the Contract, for which amount well and truly to be made, we bind ourselves, our heirs, executors and administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that, if the Contractor, their or its heirs, executors, administrators, successors or assigns, shall in all things stand to and abide by, and well and truly keep and perform the covenants, conditions and agreements in the Contract Documents and any alteration thereof made as therein provided, on its part, to be kept and performed at the time and in the manner therein specified, and in all respects according to their intent and meaning; and shall faithfully fulfill all obligations including the one-year guarantee of all materials and workmanship; and shall indemnify and save harmless the City, its officers and agents, as stipulated in said Contract Documents, then this obligation shall become null and void; otherwise it shall be and remain in full force and effect.

As a part of the obligation secured hereby and in addition to the face amount specified therefore, there shall be included costs and reasonable expenses and fees incurred by City in enforcing such obligation.

As a condition precedent to the satisfactory completion of the Contract Documents, unless otherwise provided for in the Contract Documents, the above obligation shall hold good for a period of one (1) year after the acceptance of the work by City, during which



time if Contractor shall fail to make full, complete, and satisfactory repair and replacements and totally protect the City from loss or damage resulting from or caused by defective materials or faulty workmanship. The obligations of Surety hereunder shall continue so long as any obligation of Contractor remains. Nothing herein shall limit the City's rights or the Contractor or Surety's obligations under the Contract, law or equity, including, but not limited to, California Code of Civil Procedure section 337.15.

Whenever Contractor shall be, and is declared by the City to be, in default under the Contract Documents, the Surety shall remedy the default pursuant to the Contract Documents, or shall promptly, at the City's option:

- (1) Take over and complete the Project in accordance with all terms and conditions in the Contract Documents; or
- (2) Obtain a bid or bids for completing the Project in accordance with all terms and conditions in the Contract Documents and upon determination by Surety of the lowest responsive and responsible bidder, arrange for a Contract between such bidder, the Surety and the City, and make available as work progresses sufficient funds to pay the cost of completion of the Project, less the balance of the contract price, including other costs and damages for which Surety may be liable. The term "balance of the contract price" as used in this paragraph shall mean the total amount payable to Contractor by the City under the Contract and any modification thereto, less any amount previously paid by the City to the Contractor and any other offsets pursuant to the Contract Documents.
- (3) Permit the City to complete the Project in any manner consistent with California law and make available as work progresses sufficient funds to pay the cost of completion of the Project, less the balance of the contract price, including other costs and damages for which Surety may be liable. The term "balance of the contract price" as used in this paragraph shall mean the total amount payable to Contractor by the City under the Contract and any modification thereto, less any amount previously paid by the City to the Contractor and any other offsets pursuant to the Contract Documents.

Surety expressly agrees that the City may reject any contractor or subcontractor which may be proposed by Surety in fulfillment of its obligations in the event of default by the Contractor.

Surety shall not utilize Contractor in completing the Project nor shall Surety accept a bid from Contractor for completion of the Project if the CITY, when declaring the Contractor in default, notifies Surety of the City's objection to Contractor's further participation in the completion of the Project.

The Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract Documents or to the Project to be performed thereunder shall in any way affect its obligations on this bond, and it does



hereby waive notice of any such change, extension of time, alteration or addition to the terms of the Contract Documents or to the Project, including but not limited to the provisions of sections 2819 and 2845 of the California Civil Code.

[CONTINUED ON FOLLOWING PAGE]



IN WITNESS WHEREOF, we have hereunto set our hands and seals this \_\_\_\_\_ day  
of \_\_\_\_\_, 20\_\_\_\_.

\_\_\_\_\_  
Contractor/ Principal (Corporate Seal)

By \_\_\_\_\_

Title \_\_\_\_\_  
(Attach Acknowledgment Form)

\_\_\_\_\_  
Surety (Corporate Seal)

By \_\_\_\_\_

Attorney-in-Fact  
(Attach Attorney-in-Fact Certificate)

Title \_\_\_\_\_

**Signatures of those signing for the Contractor and Surety must be notarized and evidence of corporate authority attached.**

The rate of premium on this bond is \_\_\_\_\_ per thousand. The total amount of premium charges, \$\_\_\_\_\_.

(The above must be filled in by corporate attorney.)

THIS IS A REQUIRED FORM

Any claims under this bond may be addressed to:

(Name, Address and Telephone number of  
Surety)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(Name, Address and Telephone number of  
Agent

or Representative for service of process in  
California, if different from above)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



## Notary Acknowledgment

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

STATE OF CALIFORNIA

COUNTY OF \_\_\_\_\_

On \_\_\_\_\_, 20\_\_\_\_, before me, \_\_\_\_\_, Notary Public, personally

appeared \_\_\_\_\_, who proved to me on the basis of satisfactory

evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Signature of Notary Public

### OPTIONAL

*Though the information below is not required by law, it may prove valuable to persons relying on the document and could prevent fraudulent removal and reattachment of this form to another document.*

#### CAPACITY CLAIMED BY SIGNER

#### DESCRIPTION OF ATTACHED DOCUMENT

☐ Individual

☐ Corporate Officer

Title(s)

Title or Type of Document

☐ Partner(s)

☐ Limited

☐ General

Number of Pages

☐ Attorney-In-Fact

☐ Trustee(s)

☐ Guardian/Conservator

☐ Other:

Date of Document

Signer is representing:

Name Of Person(s) Or Entity(ies)

Signer(s) Other Than Named Above

**NOTE:** A copy of the Power-of-Attorney authorizing the person signing on behalf of the Surety to do so must be attached hereto.



## 00620 - PAYMENT BOND

KNOW ALL PERSONS BY THESE PRESENTS:

THAT WHEREAS, CITY OF SANTEE (hereinafter designated as the "City"), by action taken or a resolution passed on \_\_\_\_\_, 20\_\_\_\_, has awarded to

\_\_\_\_\_,  
hereinafter designated as the "Principal," a contract for the work described as follows:  
Santee Community Center (CIP 2018-31), (the "Project"); and

WHEREAS, the work to be performed by the Principal is more particularly set forth in the Contract Documents for the Project dated \_\_\_\_\_ ("Contract Documents"), the terms and conditions of which are expressly incorporated by reference; and

WHEREAS, said Principal is required to furnish a bond in connection with said contract; providing that if said Principal or any of its Subcontractors shall fail to pay for any materials, provisions, provender, equipment, or other supplies used in, upon, for or about the performance of the work contracted to be done, or for any work or labor done thereon of any kind, or for amounts due under the Unemployment Insurance Code or for any amounts required to be deducted, withheld, and paid over to the Employment Development Department from the wages of employees of said Principal and its Subcontractors with respect to such work or labor the Surety on this bond will pay for the same to the extent hereinafter set forth.

NOW THEREFORE, we, the Principal and \_\_\_\_\_,  
as Surety, are held and firmly bound unto the City in the penal sum of

Dollars (\$\_\_\_\_\_) lawful money of the United States of America, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH that if said Principal, their or its subcontractors, heirs, executors, administrators, successors or assigns, shall fail to pay any of the persons named in Section 9100 of the Civil Code, fail to pay for any materials, provisions or other supplies, used in, upon, for or about the performance of the work contracted to be done, or for any work or labor thereon of any kind, or amounts due under the Unemployment Insurance Code with respect to work or labor performed under the contract, or for any amounts required to be deducted, withheld, and paid over to the Employment Development Department or Franchise Tax Board from the wages of employees of the contractor and his subcontractors pursuant to Section 18663 of the Revenue and Taxation Code, with respect to such work and labor the Surety or Sureties will pay for the same, in an amount not exceeding the sum herein above specified, and also, in case suit is brought upon this bond, all litigation expenses incurred by the City in such suit, including reasonable attorneys' fees, court costs, expert witness fees and investigation expenses.



This bond shall inure to the benefit of any of the persons named in Section 9100 of the Civil Code so as to give a right of action to such persons or their assigns in any suit brought upon this bond.

It is further stipulated and agreed that the Surety on this bond shall not be exonerated or released from the obligation of this bond by any change, extension of time for performance, addition, alteration or modification in, to, or of any contract, plans, specifications, or agreement pertaining or relating to any scheme or work of improvement herein above described, or pertaining or relating to the furnishing of labor, materials, or equipment therefore, nor by any change or modification of any terms of payment or extension of the time for any payment pertaining or relating to any scheme or work of improvement herein above described, nor by any rescission or attempted rescission or attempted rescission of the contract, agreement or bond, nor by any conditions precedent or subsequent in the bond attempting to limit the right of recovery of claimants otherwise entitled to recover under any such contract or agreement or under the bond, nor by any fraud practiced by any person other than the claimant seeking to recover on the bond and that this bond be construed most strongly against the Surety and in favor of all persons for whose benefit such bond is given, and under no circumstances shall Surety be released from liability to those for whose benefit such bond has been given, by reason of any breach of contract between the owner or City and original contractor or on the part of any obligee named in such bond, but the sole conditions of recovery shall be that claimant is a person described in Section 9100 of the Civil Code, and has not been paid the full amount of their claim and that Surety does hereby waive notice of any such change, extension of time, addition, alteration or modification herein mentioned and the provisions of sections 2819 and 2845 of the California Civil Code.

IN WITNESS WHEREOF, three (3) identical counterparts of this instrument, each of which shall for all purposes be deemed unoriginal thereof, have been duly executed by the Principal and Surety above named, on the \_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative pursuant to authority of its governing body.

[Continued on next page]



\_\_\_\_\_  
Contractor/ Principal (Corporate Seal)

By \_\_\_\_\_

Title \_\_\_\_\_  
(Attach Acknowledgment Form)

\_\_\_\_\_  
Surety (Corporate Seal)

By \_\_\_\_\_

Attorney-in-Fact  
(Attach Attorney-in-Fact Certificate)

Title \_\_\_\_\_

**NOTE:** Signatures of those signing for the Contractor and Surety must be notarized and evidence of corporate authority attached. A Power-of-Attorney authorizing the person signing on behalf of the Surety to so MUST BE ATTACHED hereto.



## Notary Acknowledgment

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

STATE OF CALIFORNIA

COUNTY OF \_\_\_\_\_

On \_\_\_\_\_, 20\_\_\_\_, before me, \_\_\_\_\_, Notary Public, personally

appeared \_\_\_\_\_, who proved to me on the basis of satisfactory

evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Signature of Notary Public

### OPTIONAL

*Though the information below is not required by law, it may prove valuable to persons relying on the document and could prevent fraudulent removal and reattachment of this form to another document.*

#### CAPACITY CLAIMED BY SIGNER

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Title(s)

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☐ General

Number of Pages

☐ Attorney-In-Fact

☐ Trustee(s)

☐ Guardian/Conservator

☐ Other:

Date of Document

Signer is representing:

Name Of Person(s) Or Entity(ies)

Signer(s) Other Than Named Above

**NOTE:** A copy of the Power-of-Attorney authorizing the person signing on behalf of the Surety to do so must be attached hereto.



## 00700 - GENERAL CONDITIONS

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## ARTICLE 1. DEFINITIONS

- a. Acceptable, Acceptance or words of similar import shall be understood to be the acceptance of the Engineer and/or the City.
- b. Act of God is an earthquake of magnitude 3.5 or higher on the Richter scale or a tidal wave.
- c. Applicable Laws means laws, statutes, ordinances, rules, codes, regulations, permits and licenses of any kind, issued by local, state or federal governmental authorities or private authorities with jurisdiction (including utilities), to the extent they apply to the Work.
- d. Approval means written authorization by Engineer and/or City.
- e. Contract Documents includes all documents as stated in the Contract.
- f. Change Order that portion of the Contract Documents consisting of the written order to the Contractor signed by the City authorizing additions, deletions, or other revisions, the Contract amount and Contract time being adjusted accordingly.
- g. City and Contractor are those stated in the Contract. The terms City and Owner may be used interchangeably.
- h. Day shall mean calendar day unless otherwise specifically designated.
- i. Engineer shall mean the City Engineer, or their or her designee, of the City of Santee, acting either directly or through properly authorized agents, such as agents acting within the scope of the particular duties entrusted to them. Also sometimes referred to as the "City's Representative" or "Representative" in the Contract Documents.
- j. Equal, Equivalent, Satisfactory, Directed, Designated, Selected, As Required and similar words shall mean the written approval, selection, satisfaction, direction, or similar action of the Engineer and/or City.
- k. Indicated, Shown, Detailed, Noted, Scheduled or words of similar meaning shall mean that reference is made to the drawings, unless otherwise noted. It shall be understood that the direction, designation, selection, or similar import of the Engineer and/or City is intended, unless stated otherwise.
- l. Install means the complete installation of any item, equipment or material.
- m. Material shall include machinery, equipment, manufactured articles, or construction such as form work, fasteners, etc., and any other classes of material to be furnished in connection with the Contract. All materials shall be new unless specified otherwise.



- n. Perform shall mean that the Contractor, at Contractor's expense, shall take all actions necessary to complete The Work, including furnishing of necessary labor, tools, and equipment, and providing and installing Materials that are indicated, specified, or required to complete such performance.
- o. Project is The Work planned by City as provided in the Contract Documents.
- p. Provide shall include provide complete in place, that is furnish, install, test and make ready for use.
- q. Recyclable Waste Materials shall mean materials removed from the Project site which are required to be diverted to a recycling center rather than an area landfill. Recyclable Waste Materials include asphalt, concrete, brick, concrete block, and rock. The project shall comply with SMC Chapters 9.02 and 9.04 that pertain to solid waste management and demolition and construction debris recycling.
- r. Specifications means that portion of the Contract Documents consisting of the written requirements for materials, equipment, construction systems, standards and workmanship for the work. Except for Sections 1-9 of the Standard Specifications for Public Works Construction ("Greenbook"), 2009 Edition, which are specifically excluded from incorporation into these Contract Documents, the Work shall be done in accordance with the Greenbook, including all current supplements, addenda, and revisions thereof. In the case of conflict between the Greenbook and the Contract Documents, the Contract Documents shall prevail.
- s. Water Agency Standards (WAS) refers to a common set of standard specifications and design guidelines for water, recycled water, and sewer facilities including construction specifications, standard drawings, and an approved materials list.
- t. The Work means the entire improvement planned by the City pursuant to the Contract Documents.
- u. Work means labor, equipment and materials incorporated in, or to be incorporated in the construction covered by the Contract Documents.

## **ARTICLE 2. CONTRACT DOCUMENTS**

- a. **Contract Documents.** The Contract Documents are complementary, and what is called for by one shall be as binding as if called for by all.
- b. **Interpretations.** The Contract Documents are intended to be fully cooperative and to be complementary. If Contractor observes that any documents are in conflict, the Contractor shall promptly notify the Engineer



in writing. In case of conflicts between the Contract Documents, the order of precedence shall be as follows:

1. Change Orders or Work Change Directives, the most recent first
2. Addenda, the most recent first
3. Environmental documents and approvals
4. Special Provisions (or Special Conditions)
5. Technical Specifications
6. Plans (Contract Drawings)
7. Contract
8. General Conditions
9. Water Agency Standards (WAS)
10. Instructions to Bidders
11. Notice Inviting Bids
12. Contractor's Bid Forms
13. Standard Specifications
14. Standard Plans
15. Reference Documents

With reference to the Drawings, the order of precedence shall be as follows:

1. Figures govern over scaled dimensions
2. Detail drawings govern over general drawings
3. Addenda or Change Order drawings govern over Contract Drawings
4. Contract Drawings govern over Standard Drawings
5. Contract Drawings govern over Shop Drawings

- c. **Conflicts in Contract Documents.** Notwithstanding the orders of precedence established above, in the event of conflicts, the higher standard shall always apply.



- d. **Organization of Contract Documents.** Organization of the Contract Documents into divisions, sections, and articles, and arrangement of drawings shall not control the Contractor in dividing The Work among subcontractors or in establishing the extent of Work to be performed by any trade.

### **ARTICLE 3. CONTRACT DOCUMENTS: COPIES & MAINTENANCE**

Contractor shall be responsible to furnish all copies of the Contract Documents necessary to perform the work. Additional copies may be obtained at cost of reproduction.

Contractor shall maintain a clean, undamaged set of Contract Documents at the Project site for review by the City, Engineer, Architect, Inspectors or any other 3<sup>rd</sup> party performing work on the project on the owners, Contractors, or Subcontractors behalf.

### **ARTICLE 4. DETAIL DRAWINGS AND INSTRUCTIONS**

- a. **Examination of Contract Documents.** Before commencing any portion of The Work, Contractor shall again carefully examine all applicable Contract Documents, the Project site and other information given to Contractor as to materials and methods of construction and other Project requirements. Contractor shall immediately notify the Engineer in writing of any potential error, inconsistency, ambiguity, conflict or lack of detail or explanation. If Contractor performs, permits, or causes the performance of any Work which is in error, inconsistent or ambiguous, or not sufficiently detailed or explained, Contractor shall bear any and all resulting costs, including, without limitation, the cost of correction. In no case shall the Contractor or any subcontractor proceed with Work if uncertain as to the applicable requirements.
- b. **Request for Information: Additional Instructions.** Contractor may make a written request for information to address any error, inconsistency, ambiguity, conflict or lack of detail or explanation in the Contract Documents. The Engineer will provide any required additional instructions, by means of drawings or other written direction, necessary for proper execution of Work.
- c. **Quality of Parts, Construction and Finish.** All parts of The Work shall be of the best quality of their respective kinds and the Contractor must use all diligence to inform itself fully as to the required construction and finish. In no case shall Contractor proceed with the Work without obtaining first from the Engineer such written Approval as may be necessary for the proper performance of Work.
- d. **Contractor's Variation from Contract Document Requirements.** If it is found that the Contractor has varied from the requirements of the Contract Documents including the requirement to comply with all applicable laws,



ordinances, rules and regulations, the Engineer may at any time, before or after completion of the Work, order the improper Work removed, remade or replaced by the Contractor at the Contractor's expense.

## **ARTICLE 5. EXISTENCE OF UTILITIES AT THE WORK SITE**

### **a. Existing Utilities**

1. General – Known existing utilities and pipelines are shown on the Plans in their approximate locations. However, nothing herein shall be deemed to require the City to indicate the presence of existing service laterals or appurtenances whenever the presence of such utilities can be inferred from the presence of other visible facilities, such as buildings, cleanouts, meter and junction boxes, on or adjacent to the site of the Project.
2. The City will assume the responsibility for the timely removal, relocation, or protection of existing main or trunk line utility facilities located on the Project site if such utilities are not identified by the City in the Contract Documents or cannot reasonably be inferred from the presence of other visible facilities.

### **b. Utility Location**

1. It shall be the Contractor's responsibility to determine the exact location and depth of all utilities, including service connections, which have been marked by the respective utility owners and which the Contractor believes may affect or be affected by the Contractor's operations. The Contractor shall not be entitled to additional compensation or time extensions for work necessary to avoid interferences or for repair to damaged utilities if the Contractor does not expose all such existing utilities as required by this section. The Contractor shall provide 3<sup>rd</sup> party utility location services for the Contract in order to locate all existing underground utilities or facilities on the project site which are not located by the Underground Service Alert of Southern California (USA).
2. The locating of utilities shall be in conformance with Government Code section 4216 et seq. except for the City's utilities located on the City's property and not in public right-of-way.
3. A "High Priority Subsurface Installation" is defined in section 4216 (e) as "high-pressure natural gas pipelines with normal operating pressures greater than 415kPA gauge (60psig) or greater than six inches nominal pipe diameter, petroleum pipelines, pressurized sewage pipelines, high-voltage electric supply lines, conductors, or cables that have a potential to ground of greater than or equal to



50kv, or hazardous materials pipelines that are potentially hazardous to workers of the public if damaged.”

4. A “Subsurface Installation” is defined in section 4216 (l) as “any underground pipeline, conduit, duct, wire, or other structure, except non-pressurized sewer lines, non-pressurized storm drains, or other non-pressurized drain lines.”
5. Pursuant to Government Code section 4216.2, the Contractor shall contact the appropriate regional notification center at least two (2) working days but not more than 14 Days before performing any excavation. The Contractor shall request that the utility owners conduct a utility survey and mark or otherwise indicate the location of their service. The Contractor shall furnish to the City written documentation of its contact(s) with the regional notification center prior to commencing excavation at such locations.
6. After the utility survey is completed, the Contractor shall commence “potholing” or hand digging to determine the actual location of the pipe, duct, or conduit. The City shall be given written notice prior to commencing potholing operations. The Contractor shall uncover all piping and conduits, to a point one (1) foot below the pipe, where crossings, interferences, or connections are shown on the Drawings, prior to trenching or excavating for any pipe or structures, to determine actual elevations. New pipelines shall be laid to such grade as to clear all existing facilities, which are to remain in service for any period subsequent to the construction of the run of pipe involved.
7. The Contractor’s attention is directed to the requirements of Government Code section 4216.2 (a)(2) which provides: “When the excavation is proposed within 10 feet of a high priority subsurface installation, the operator of the high priority subsurface installation shall notify the excavator of the existence of the high priority subsurface installation prior to the legal excavation start date and time, as such date and time are authorized pursuant to paragraph (1) of subdivision (a) of section 4216.2. The excavator and the operator or its representative shall conduct an onsite meeting at a mutually-agreed-on time to determine actions of activities required to verify the location of the high priority subsurface installation prior to start time.” The Contractor shall notify the City in advance of this meeting.

c. Utility Relocation and Repair

1. If interferences occur at locations other than those indicated in the Contract Documents with reasonable accuracy, Contractor shall notify the City in writing.



2. Care shall be exercised by the Contractor to prevent damage to adjacent existing facilities and public or private works; where equipment will pass over these obstructions, suitable planking shall be placed. If high priority subsurface installations are damaged and the operator cannot be contacted, Contractor shall call 911 emergency services.
3. City will compensate the Contractor for the costs of repairing damage not due to the failure of the Contractor to exercise reasonable care, and for removing or relocating such main or trunk line utility facilities not indicated in the Contract Documents with reasonable accuracy, and for the cost of equipment on the Project necessarily idled during such work. The payment of such costs will be made as provided in ARTICLE 45 (Changes and Extra Work). The Contractor shall not be assessed liquidated damages for delay in completion of the Project when such delay is caused by the failure of a utility company to provide for removal or relocation of such utility facilities. Requests for extensions of time arising out of utility relocation or repair delays shall be filed in accordance with ARTICLE 45.
4. The public utility, where they are the owner of the affected utility, shall have the sole discretion to perform repairs or relocation work or permit the Contractor to do such repairs or relocation work at a reasonable price. The right is reserved to the City and the owners of utilities or their authorized agents to enter upon the Work area for the purpose of making such changes as are necessary for the rearrangement of their facilities or for making necessary connections or repairs to their properties. The Contractor shall cooperate with forces engaged in such work and shall conduct its operations in such a manner as to avoid any unnecessary delay or hindrance to the work being performed by such forces and shall allow the respective utilities time to relocate their facility.
5. When the Contract Documents indicate that a utility is to be relocated, altered or constructed by others, the City will conduct all negotiations with the utility company and the work will be done at no cost to the Contractor, unless otherwise stipulated in the Contract.
6. Temporary or permanent relocation or alteration of utilities desired by the Contractor for its own convenience shall be the Contractor's responsibility and it shall make arrangements and bear all costs for such work.

## **ARTICLE 6. SCHEDULE**

- a. **General Requirements.** The schedule shall be prepared in a Critical Path Method ("CPM") format and in an electronic scheduling program acceptable



to the City. Contractor shall deliver the schedule and all updates to the City in both paper and electronic form. The electronic versions shall be in the format and include all data used to prepare the schedule; pdf. Copies are not acceptable.

- b. **Initial Schedule.** Within fourteen (14) days after the issuance of the Notice to Proceed (NTP), Contractor shall prepare a schedule for the performance of the Work and shall submit this to the Engineer for Approval. The receipt or Approval of any schedules by the Engineer or the City shall not in any way relieve the Contractor of its obligations under the Contract Documents. The Contractor is fully responsible to determine and provide for any and all staffing resources at levels which allow for good quality and timely completion of the Project. Contractor's failure to incorporate all elements of Work required for the performance of the Contract or any inaccuracy in the schedule shall not excuse the Contractor from performing all Work required for a completed Project within the specified Contract time period. If the required schedule is not received by the time the first payment under the Contract is due, Contractor shall not be paid until the schedule is received, reviewed, and accepted by the Engineer.
- c. **Schedule Contents.** The schedule shall allow enough time for inclement weather that can reasonably be expected at the Site. The schedule shall indicate the beginning and completion date of all phases of construction; critical path for all critical, sequential time related activities; and "float time" for all "slack" or "gaps" in the non-critical activities. The schedule shall clearly identify all staffing and other resources which in the Contractor's judgment are needed to complete the Project within the Contract Time. Schedule duration shall match the Contract Time. Schedules indicating early completion will be rejected.
- d. **Schedule Updates.** Contractor shall continuously update its construction schedule to show the actual status of the Work and incorporate changes in the Work. Contractor shall submit an updated and accurate construction schedule to the Engineer whenever requested to do so by Engineer and with each progress payment request. The Engineer may withhold progress payments or other amounts due under the Contract Documents if Contractor fails to submit an updated and accurate construction schedule.

## ARTICLE 7. SUBSTITUTIONS

- a. Pursuant to Public Contract Code Section 3400(b), the City may make a finding that is described in the invitation for bids that designates certain products, things, or services by specific brand or trade name.
- b. Unless specifically designated in the Contract Documents, whenever any material, process, or article is indicated or specified by grade, patent, or proprietary name or by name of manufacturer, such Specifications shall be



deemed to be used for the purpose of facilitating the description of the material, process, or article desired and shall be deemed to be followed by the words "or equal." Contractor may, unless otherwise stated, offer for substitution any material, process or article which shall be substantially equal or better in every respect to that so indicated or specified in the Contract Documents. However, the City may have adopted certain uniform standards for certain materials, processes and articles.

- c. Contractor shall submit written requests, together with substantiating data, for substitution of any "or equal" material, process or article no later than thirty-five (35) days after award of the Contract. To facilitate the construction schedule and sequencing, some requests may need to be submitted before thirty-five (35) days after award of Contract. Provisions regarding submission of "or equal" requests shall not in any way authorize an extension of time for performance of this Contract. If a proposed "or equal" substitution request is rejected, Contractor shall be responsible for providing the specified material, process or article without adjustment to the Contract Price or Contract Time. The burden of proof as to the equality of any material, process or article shall rest with the Contractor. The City has the complete and sole discretion to determine if a material, process or article is an "or equal" material, process or article that may be substituted.
- d. Data required to substantiate requests for substitutions of an "or equal" material, process or article data shall include a signed affidavit from the Contractor stating that, and describing how, the substituted "or equal" material, process or article is equivalent to that specified in every way except as listed on the affidavit. Substantiating data shall include any and all illustrations, specifications, and other relevant data including catalog information which describes the requested substituted "or equal" material, process or article, and substantiates that it is an "or equal" to the material, process or article. The substantiating data must also include information regarding the durability and lifecycle cost of the requested substituted "or equal" material, process or article. Failure to submit all the required substantiating data, including the signed affidavit, to the City in a timely fashion will result in the rejection of the proposed substitution.
- e. The Contractor shall bear all of the City's costs associated with the review of substitution requests.
- f. The Contractor shall be responsible for all costs related to a substituted "or equal" material, process or article.
- g. Contractor is directed to the Special Conditions (if any) to review any findings made pursuant to Public Contract Code section 3400.



## **ARTICLE 8. SHOP DRAWINGS**

- a. Contractor shall check and verify all field measurements and shall submit with such promptness as to provide adequate time for review and cause no delay in their own Work or in that of any other contractor, subcontractor, or worker on the Project, six (6) copies of all shop or setting drawings, calculations, schedules, and materials list, and all other provisions required by the Contract. Contractor shall sign all submittals affirming that submittals have been reviewed and approved by Contractor prior to submission to Engineer. Each signed submittal shall affirm that the submittal meets all the requirements of the Contract Documents except as specifically and clearly noted and listed on the cover sheet of the submittal.
- b. Contractor shall make any corrections required by the Engineer, and file with the Engineer six (6) corrected copies each, and furnish such other copies as may be needed for completion of the Work. Engineer's approval of shop drawings shall not relieve Contractor from responsibility for deviations from the Contract Documents unless Contractor has, in writing, called Engineer's attention to such deviations at time of submission and has secured the Engineer's written Approval. Engineer's Approval of shop drawings shall not relieve Contractor from responsibility for errors in shop drawings.

## **ARTICLE 9. SUBMITTALS**

- a. Contractor shall furnish to the Engineer for approval, prior to purchasing or commencing any Work, a log of all samples, material lists and certifications, mix designs, schedules, and other submittals, as required in the specifications. The log shall indicate whether samples will be provided in accordance with other provisions of this Contract.
- b. Contractor will provide samples and submittals, together with catalogs and supporting data required by the Engineer, to the Engineer within a reasonable time period to provide for adequate review and avoid delays in the Work.
- c. These requirements shall not authorize any extension of time for performance of this Contract. Engineer will check and approve such samples, but only for conformance with design concept of work and for compliance with information given in the Contract Documents. Work shall be in accordance with approved samples and submittals.
- d. Submittal procedure shall be in accordance with Section 013300 - Submittal Procedure - unless otherwise specified.
- e. Contractor shall not be entitled to any extension of the Contract Time on account of the requirements of this ARTICLE 9.



## **ARTICLE 10. MATERIALS**

- a. Except as otherwise specifically stated in the Contract Documents, Contractor shall provide and pay for all materials, labor, tools, equipment, water, lights, power, transportation, superintendence, temporary constructions of every nature, and all other services and facilities of every nature whatsoever necessary to execute and complete this Contract within the Contract Time.
- b. Unless otherwise specified, all materials shall be new and the best of their respective kinds and grades as noted and/or specified, and workmanship shall be of good quality. Any materials that have been rejected shall immediately be removed from the site of work at the Contractor's expense.
- c. Materials shall be furnished in ample quantities and at such times as to ensure uninterrupted progress of The Work and shall be stored properly and protected as required by the Contract Documents. Contractor shall be entirely responsible for damage or loss by weather or other causes to materials or Work.
- d. No materials, supplies, or equipment for Work under this Contract shall be purchased subject to any chattel mortgage or under a conditional sale or other agreement by which an interest therein or in any part thereof is retained by the seller or supplier. Contractor warrants good title to all material, supplies, and equipment installed or incorporated in the work and agrees upon completion of all work to deliver the Project, to the City free from any claims, liens, or charges.
- e. Materials shall be stored on the Project site in such manner so as not to interfere with any operations of the City or any independent contractor.
- f. The Contractor's responsibility for materials furnished by the City shall begin upon Contractor's acceptance at the point of delivery to Contractor. All such materials shall be examined, and material defective in manufacture or otherwise damaged shall be rejected by the Contractor and will be replaced by the City. Materials furnished by the City which are accepted by the Contractor, but which are discovered prior to final acceptance of the Work to have been damaged before or after acceptance by the Contractor, shall be replaced by the Contractor. Once accepted by the Contractor at the point of delivery to Contractor, all defective and/or damaged material discovered prior to final acceptance of the Work shall be removed by the Contractor and Contractor shall install, the material replaced by the Contractor, at its own expense.
- g. The Contractor shall be responsible for the safe storage of all materials until they have been incorporated in the completed project. Tools and equipment satisfactory to the City shall be provided and used by the Contractor for the



safe and efficient execution of the Work. All pipe, valves, fittings, and accessories shall be handled in such a manner as to prevent damage thereto.

## **ARTICLE 11. CONTRACTOR'S SUPERVISION**

The Contractor shall designate in writing and shall continuously keep at the Project site, a competent and experienced full-time Project superintendent acceptable to the City. The project superintendent shall have not less than 10-years of experience in the work being constructed for the Contract. The project superintendent shall be an employee of the Contractor and shall not be replaced without written notice to the City. The superintendent must be able to proficiently speak, read, and write in English. The construction superintendent will be the Contractor's representative at the site and shall have full authority to act on behalf of the Contractor, through completion of the work unless he ceases to be on the Contractor's payroll.

The Contractor's construction superintendent shall be present or available at the work site at all times while work is in progress during normal working hours, and shall be available by phone for emergencies 24 hours a day, 7 days a week. Failure to observe this requirement shall be consideration for suspension of work. The construction superintendent shall be responsible for but not limited to the following:

1. Receiving direction or instructions from the City.
2. Construction scheduling and project coordination.
3. Work necessary for completion of the project as described in the project plans and documents.

Upon written notice, the City may require replacement of the Contractor's construction superintendent with cause, in which case the Contractor shall submit a replacement construction superintendent subject to approval by the City, at no additional cost and time to the City.

Contractor shall continuously provide efficient supervision of the Project.

## **ARTICLE 12. WORKERS**

- a. Contractor shall at all times enforce strict discipline and good order among its employees and subcontractors. Contractor shall not employ or allow subcontractors to employ on the Project any unfit person or any one not skilled in the Work assigned to him or her.
- b. Where in the opinion of the Engineer, the employment of skilled laborers is necessary for the successful performance of the Work to be done under the Contract Documents, then only such persons who have had experience in, and can show themselves to be skillful in their particular line of work shall



be employed by the Contractor. Whenever the City shall decide that any person employed on any portion of the work is incompetent, unskilled, disrespectful, disobedient, disorderly, or in any way detrimental to the interests of the City, then such person shall be discharged by the Contractor from the Work, and shall not be employed upon any portion of the Work during its construction.

- c. Any person in the employ of the Contractor whom the City may deem incompetent or unfit shall be dismissed from The Work and shall not be employed on this Project except with the written Approval of the City.

### **ARTICLE 13. SUBCONTRACTORS**

- a. Contractor agrees to bind every subcontractor to the terms of the Contract Documents as far as such terms are applicable to subcontractor's portion of The Work. Contractor shall be as fully responsible to the City for the acts and omissions of its subcontractors and of persons either directly or indirectly employed by its subcontractors, as Contractor is for acts and omissions of persons directly employed by Contractor. Nothing contained in these Contract Documents shall create any contractual relationship between any subcontractor and the City.
- b. The City reserves the right to Approve all subcontractors. The City's Approval of any subcontractor under this Contract shall not in any way relieve Contractor of its obligations in the Contract Documents.
- c. Prior to substituting any subcontractor listed in the Bid Forms, Contractor must comply with the requirements of the Subletting and Subcontracting Fair Practices Act pursuant to California Public Contract Code section 4100 et seq.

### **ARTICLE 14. VERIFICATION OF EMPLOYMENT ELIGIBILITY**

By executing this Contract, Contractor verifies that it fully complies with all requirements and restrictions of state and federal law respecting the employment of undocumented aliens, including, but not limited to, the Immigration Reform and Control Act of 1986, as may be amended from time to time, and shall require all subcontractors, sub-subcontractors, subconsultants, sub-subconsultants, and consultants to comply with the same. Each person executing this Contract on behalf of Contractor verifies that he or she is a duly authorized officer of Contractor and that any of the following shall be grounds for the City to terminate the Contract for cause: (1) failure of the Contractor or its subcontractors, sub-subcontractors, or consultants to meet any of the requirements provided for in this ARTICLE 14; (2) any misrepresentation or material omission concerning compliance with such requirements; or (3) failure to immediately remove from the Work any person found not to be in compliance with such requirements.



## **ARTICLE 15. PERMITS AND LICENSES**

Permits and licenses necessary for prosecution of The Work shall be secured and paid for by Contractor, unless otherwise specified in the Contract Documents.

- a. Contractor shall obtain and pay for all other permits and licenses required for The Work, including excavation permit and permits for plumbing, mechanical and electrical work and for operations in or over public streets or right of way under jurisdiction of public agencies other than the City.
- b. The Contractor shall arrange and pay for all off-site inspection of the Work related to permits and licenses, including certification, required by the specifications, drawings, or by governing authorities, except for such off-site inspections delineated as the City's responsibility pursuant to the Contract Documents.
- c. Before Acceptance of the Project, the Contractor shall submit all licenses, permits, certificates of inspection and required approvals to the City.

## **ARTICLE 16. UTILITY USAGE**

- a. All temporary utilities, including but not limited to electricity, gas, and telephone, used on the Work shall be furnished and paid for by Contractor. Contractor shall provide necessary temporary distribution systems, including meters, if necessary, from distribution points to points on The Work where the utility is needed. Upon completion of The Work, Contractor shall remove all temporary distribution systems.
- b. Contractor shall provide necessary and adequate utilities and pay all costs for water, electricity, gas, and oil and sewer charges required for completion of the Project, including but not limited to startup and testing required in the Contract Documents.
- c. All permanent meters installed shall be listed in the Contractor's name until Project Acceptance.
- d. If the Contract is for construction in existing facilities, Contractor may, with prior written Approval of the City, use the City's existing utilities. If Contractor uses City utilities, it shall compensate the City for utilities used by Contractor.

## **ARTICLE 17. INSPECTION FEES FOR PERMANENT UTILITIES**

All inspection fees for permanent utilities including, but not limited to, sewer, electrical, phone, gas, water, and recycled water irrigation performed within the City shall be paid by the Contractor.



## ARTICLE 18. TRENCHES

- a. Trenches Five Feet or More in Depth. The Contractor shall submit to the City, in advance of excavation, a detailed plan showing the design of shoring, bracing, sloping or other provisions to be made for worker protection from the hazard of caving ground during the excavation of any trench or trenches five feet or more in depth. If the plan varies from shoring system standards, the plan shall be prepared by a registered civil or structural engineer. The plan shall not be less effective than the shoring, bracing, sloping, or other provisions of the Construction Safety Orders, as defined in the California Code of Regulations, and all costs therefor shall be included in the Contract Price. Nothing in this section shall be deemed to allow the use of a shoring, bracing, sloping or other protective system less effective than that required by the Construction Safety Orders. Nothing in this section shall be construed to impose a tort liability on the City, any of its officers, officials, partners, employees, agents, consultants or volunteers. The City's review of the Contractor's excavation plan is only for general conformance to the Construction Safety Orders and does not relieve the Contractor of any obligation hereunder. Prior to commencing any excavation, the Contractor shall designate in writing to the City the "competent person(s)" with authority and responsibilities designated in the Construction Safety Orders.
- b. Excavations Deeper than Four Feet. If work under this Contract involves digging trenches or other excavation that extends deeper than four feet below the surface, Contractor shall promptly, and before the following conditions are disturbed, notify the City, in writing, of any:
  1. Material that the Contractor believes may be material that is hazardous waste, as defined in Section 25117 of the Health and Safety Code, that is required to be removed to a Class I, Class II, or Class III disposal site in accordance with provisions of existing law.
  2. Subsurface or latent physical conditions at the site differing from those indicated by information made available to bidders prior to the deadline for submitting bids.
  3. Unknown physical conditions at the site of any unusual nature, different materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract.

The City shall promptly investigate the conditions, and if it finds that the conditions do so materially differ, or do involve hazardous waste, and cause a decrease or increase in Contractor's cost of, or the time required for, performance of any part of The Work, shall issue a change order under the procedures described in the Contract Documents.



In the event that a dispute arises between the City and the Contractor as to whether the conditions materially differ, or involve hazardous waste, or cause a decrease or increase in the Contractor's cost of, or time required for, performance of any part of The Work, the Contractor shall not be excused from any scheduled completion date provided for by the Contract, but shall proceed with all Work to be performed under the Contract. Contractor shall retain any and all rights provided either by contract or by law which pertain to the resolution of disputes and protests between the parties.

#### **ARTICLE 19. DIVERSION OF RECYCLABLE WASTE MATERIALS**

In compliance with the applicable City's waste reduction and recycling efforts, Contractor shall divert all Recyclable Waste Materials to appropriate recycling centers. The project shall comply with SMC Chapters 9.02 and 9.04 that pertain to solid waste management and demolition and construction debris recycling.

Contractor shall be required to submit weight tickets and written proof of diversion with its monthly progress payment requests. Contractor shall complete and execute any certification forms required by City or other applicable agencies to document Contractor's compliance with these diversion requirements. All costs incurred for these waste diversion efforts shall be the responsibility of the Contractor.

#### **ARTICLE 20. REMOVAL OF HAZARDOUS MATERIALS**

Should Contractor encounter material reasonably believed to be polychlorinated biphenyl (PCB) or other toxic wastes and hazardous materials (as defined in section 25117 of the Health and Safety Code), which have not been rendered harmless at the Project site, the Contractor shall immediately stop work at the affected Project site and shall report the condition to the City in writing. The City shall contract for any services required to directly remove and/or abate PCB's and other toxic wastes and hazardous materials, if required by the Project site(s), and shall not require the Contractor to subcontract for such services. The Work in the affected area shall not thereafter be resumed except by written agreement of the City and Contractor.

#### **ARTICLE 21. SANITARY FACILITIES**

Contractor shall provide sanitary temporary toilet buildings for the use of all workers. All toilets shall comply with all applicable federal, state and local laws, codes, ordinances, and regulations. Toilets shall be kept supplied with toilet paper and shall have workable door fasteners. Toilets shall be serviced no less than once weekly and shall be present in a quantity of not less than 1 per 20 workers as required by CAL-OSHA regulation. The toilets shall be maintained in a sanitary condition at all times. Use of toilet facilities in The Work under construction shall not be permitted. Any other Sanitary Facilities required by CAL-OSHA shall be the responsibility of the Contractor.



## **ARTICLE 22. AIR POLLUTION CONTROL**

Contractor shall comply with all air pollution control rules, regulations, ordinances and statutes. All containers of paint, thinner, curing compound, solvent or liquid asphalt shall be labeled to indicate that the contents fully comply with the applicable material requirements. Without limiting the foregoing, Contractor must fully comply with all Applicable Laws, rules and regulations in furnishing or using equipment and/or providing services, including but not limited to, emissions limits and permitting requirements imposed by the Air Quality Management City with jurisdiction over the Project and/or California Air Resources Board (CARB). Contractor shall specifically be aware of the application of these limits and requirements to "portable equipment" which definition is considered to include any item of equipment with a fuel-powered engine. Contractor shall indemnify City against any fines or penalties imposed by the air quality management district, CARB, or any other governmental or regulatory agency for its violations of Applicable laws as well as those of its subcontractors or others for whom Contractor is responsible under its indemnity obligations provided for in ARTICLE 47.

## **ARTICLE 23. COMPLIANCE WITH STATE STORM WATER PERMIT**

- a. Storm, surface, ground, nuisance, or other waters may be encountered at various times during the Work. Contractor hereby acknowledges that it has investigated the risk arising from such waters, has prepared its Bid accordingly, and assumes any and all risks and liabilities arising therefrom.
- b. Contractor shall keep itself and all subcontractors, staff, and employees fully informed of, adequately trained in, and in compliance with all local, state and federal laws, rules and regulations that may impact, or be implicated by the performance of the Work including, without limitation, all applicable provisions of the Federal Water Pollution Control Act (33 U.S.C. § 1251 *et seq.*); the California Porter-Cologne Water Quality Control Act (Water Code § 13000 *et seq.*); and any and all regulations, ordinances, policies, or permits issued pursuant to any such authority. For all projects that involve construction on or disturbance of one acre or more of land or which are part of a larger common area of development, these include, but are not limited to, State Water Resources Control Board ("State Water Board") National Pollutant Discharge Elimination System General Permit for Waste Discharge Requirements for Discharges of Storm Water Discharges associated with Construction Activity, Water Quality Order No. 2009-0009-DWQ as modified by Order Nos. 2010-0014-DWQ and 2012-0006-DWQ and any other subsequent amendment, renewal, or reissuance, ("Permit"), and to the extent applicable, with any requirements imposed pursuant to San Diego Regional Water Quality Control Board Order No. R9-2013-0001 and any amendments, modification, renewal or reissuance thereof.
- c. Contractor shall file the Notice of Intent and obtain coverage for the Project under the Permit and shall file all necessary documentation, including Permit Registration Documents through the Stormwater Multiple



Applications and Report Tracking System, prepare and implement a Storm Water Pollution Prevention Plan ("SWPPP") prior to initiating Work, implement all other provisions, and monitoring and reporting requirements set out in the Permit, and provide a Qualified SWPPP Developer and Qualified SWPPP Practitioner necessary for all Work site activities. In bidding on this Contract, it shall be Contractor's responsibility to evaluate the cost of procuring the Permit and preparing the SWPPP as well as complying with the SWPPP and any necessary revision to the SWPPP. Contractor shall comply with all requirements of the State Water Resources Control Board. Contractor shall include all costs of compliance with specified requirements in the Contract amount.

- d. Contractor shall be responsible for procuring, implementing and complying with the provisions of the Permit and the SWPPP, including the standard provisions, monitoring and reporting requirements as required by the Permit. Contractor shall provide copies of all reports and monitoring information to the Engineer.
- e. Contractor shall comply with the lawful requirements of City, State of California, Regional Water Quality Control Board, and other local agencies regarding discharges of storm water to separate storm drain system or other watercourses under their jurisdiction, including applicable requirements in municipal storm water management programs.
- f. Failure to comply with the Permit is in violation of federal and state law. Contractor hereby agrees to indemnify and hold harmless City, its officials, officers, agents, employees and authorized volunteers from and against any and all claims, demands, losses or liabilities of any kind or nature which City, its officials, officers, agents, employees and authorized volunteers may sustain or incur for noncompliance with the laws, regulations, ordinances, Permit, and other regulatory mechanisms referenced in this Article arising out of or in connection with the Work, except for liability resulting from the sole established negligence, willful misconduct or active negligence of the City, its officials, officers, agents, employees or authorized volunteers. City may seek damages from Contractor for delay in completing the Contract in accordance with the Contract Documents, caused by Contractor's failure to comply with the Permit, laws, regulations and policies described in this Article or in any other relevant water quality law, regulation or policy.
- g. The City reserves the right to defend any enforcement action or civil action brought against the City for Contractor's failure to comply with any applicable water quality law, regulation, or policy. Contractor hereby agrees to be bound by, and to reimburse the City for the costs associated with, any settlement reached between the City and any relevant enforcement entity.



- h. For construction activity which results in the disturbance of one acre or less of total land area, the Contractor shall be responsible for providing Best Management Practices (BMP) for erosion control measures to control soil movement and prevent storm water pollution satisfactory to the City, San Diego Regional Water Quality Control Board, County of San Diego, and/or the City of Santee. Erosion control measures shall be determined by the Contractor and shall include, but not be limited to, slope protection, desilting basins, energy dissipators, silt fences, straw bale dikes, earth dikes, gravel bagging, and storm drains. As a minimum, gravel dikes, silt fences, straw bale dikes, or equivalent control practices are required for all significant side slope and downslope boundaries of the construction area. Erosion control measures shall apply to all areas of construction activities including reservoir site, access roads, and staging and stockpile areas.
- i. All required inspections, reports, annual reports, action plans and filings of documents to the State Waterboards Website for compliance of the project shall be completed by the contractor at the contractor's expense. The project shall not be deemed completed by the Engineer until the Notice of Termination is completed and filed by the Contractor and has been accepted as complete by SMARTS Website.

#### **ARTICLE 24. CLEANING UP**

- a. Contractor at all times shall keep premises free from debris such as waste, rubbish, and excess materials and equipment. Contractor shall not store debris under, in, or about the premises. During the work and upon completion of Work, Contractor shall clean the interior and exterior of the building or improvement including fixtures, equipment, walls, floors, ceilings, roofs, window sills and ledges, horizontal projections, and any areas where debris has collected so surfaces are free from foreign material or discoloration. Contractor shall clean and polish all glass, plumbing fixtures, and finish hardware and similar finish surfaces and equipment and contractor shall also remove temporary fencing, barricades, planking and construction toilet and similar temporary facilities from site. Contractor shall also clean all buildings, asphalt and concrete areas to the degree necessary to remove oil, grease, fuel, or other stains caused by Contractor operations or equipment.
- b. Contractor shall fully clean up the site at the completion of The Work. If the Contractor fails to immediately clean up at the completion of The Work, the City may do so and the cost of such clean up shall be charged back to the Contractor.

#### **ARTICLE 25. LAYOUT AND FIELD ENGINEERING**

All field engineering required for laying out The Work and establishing grades for earthwork operations shall be furnished by the Contractor at its expense. Layout shall be



done by a qualified individual Approved by the Engineer. Any required “as-built” drawings of civil engineering elements of the Work shall be prepared by a registered civil engineer.

#### **ARTICLE 26. EXCESSIVE NOISE**

- a. The Contractor shall use only such equipment on the work and in such state of repair so that the emission of sound therefrom is within the noise tolerance level of that equipment as established by CAL-OSHA.
- b. The Contractor shall comply with the most restrictive of the following: (1) local sound control and noise level rules, regulations and ordinances and (2) the requirements contained in these Contract Documents, including hours of operation requirements. No internal combustion engine shall be operated on the Project without a muffler of the type recommended by the manufacturer. Should any muffler or other control device sustain damage or be determined to be ineffective or defective, the Contractor shall promptly remove the equipment and shall not return said equipment to the job until the device is repaired or replaced. Said noise and vibration level requirements shall apply to all equipment on the job or related to the job, including but not limited to, trucks, transit mixers or transit equipment that may or may not be owned by the Contractor.
- c. No construction equipment noise is permitted between the hours of 7:00pm to 7:00am the following day. All construction equipment operated for the Contract shall include a muffler substantial enough to dampen engine noise to 70db or lower.
- d. Construction equipment with a manufacturers noise rating of 85 dba or greater may only operate for 10 consecutive days. Should the equipment be required for more than 10 days, notice must be provided to all property owners and residents within 300 feet of the site no later than 10 days prior to the start of construction. The notice must be approved by the City and describe the project, expected duration and provide a point of contact with the Contractor to resolve noise complaints.
- e. See Section 00750 – Special Conditions, Item 10 for further requirements.

#### **ARTICLE 27. TESTS AND INSPECTIONS**

- a. If the Contract Documents, the Engineer, or any instructions, laws, ordinances, or public authority require any part of The Work to be tested or Approved, Contractor shall provide the Engineer at least two (2) working days notice of its readiness for observation or inspection. Inspectors shall be recognized as authorized agents for the City or Engineer and their duties shall be to evaluate materials used and work performed. If inspection is by a public authority other than the City, Contractor shall promptly inform the City of the date fixed for such inspection. Required certificates of inspection



(or similar) shall be secured by Contractor. Costs for City testing and City inspection shall be paid by the City. Costs of tests for Work found not to be in compliance with the Contract Documents or Applicable Law shall be paid by the Contractor. Costs for 3<sup>rd</sup> party testing shall be paid for by the City.

- b. Geotechnical/Compaction Testing: Contractor shall provide State of California Licensed 3<sup>rd</sup> party geotechnical testing and compaction testing for all earthwork, grading, trenching, aggregate bases, asphalt concrete, building pads, curbs, gutters, sidewalks, walkways and other surfaces to ensure they have been prepared, and constructed to the requirements set forth in the contract. The costs for 3<sup>rd</sup> party geotechnical/compaction testing shall be paid for by the Contractor. The Contractor shall submit to the City for approval the Geotechnical Engineering/Compaction Testing firms name, license number and qualifications for review and approval prior to the start of work.
- c. Special Inspection & Testing: Contractor shall coordinate inspection with the City of Santee's designated 3<sup>rd</sup> party special inspection firm for all testing and inspection as required to complete the work on the plans and specifications. The Contractor shall comply with instruction provided by the City's 3<sup>rd</sup> party inspectors. The Contractor shall submit all documentation requested regarding 3<sup>rd</sup> party inspection and any off-site fabrication requests to the City for approval. The costs for Special Inspection and Testing shall be paid for by the City.
- d. If any Work is done or covered up without the required testing or approval, the Contractor shall uncover or deconstruct the Work, and the Work shall be redone after completion of the testing at the Contractor's cost in compliance with the Contract Documents, at the Contractor's cost.
- e. Where inspection and testing are to be conducted by an independent laboratory or agency, materials or samples of materials to be inspected or tested shall be selected by such laboratory or agency, or by the City, and not by Contractor. All tests or inspections of materials shall be made in accordance with the commonly recognized standards of national organizations.
- f. In advance of manufacture of materials to be supplied by Contractor which must be tested or inspected, Contractor shall notify the City so that the City may arrange for testing at the source of supply. Any materials which have not satisfactorily passed such testing and inspection shall not be incorporated into The Work.
- g. If the manufacture of materials to be inspected or tested will occur in a plant or location outside the geographic limits of City, the Contractor shall pay for any excessive or unusual costs associated with such testing or inspection,



including but not limited to excessive travel time, standby time and required lodging.

- h. Reexamination of Work may be ordered by the City. If so ordered, Work must be uncovered or deconstructed by Contractor. If Work is found to be in accordance with the Contract Documents, the City shall pay the costs of reexamination and reconstruction. If such work is found not to be in accordance with the Contract Documents, Contractor shall pay all costs.

## **ARTICLE 28. PROTECTION OF WORK AND PROPERTY**

- a. The Contractor shall be responsible for all damages to persons or property that occur as a result of The Work. Contractor shall be responsible for the proper care and protection of all materials delivered and Work performed until completion and final Acceptance by the City. All Work shall be solely at the Contractor's risk. Contractor shall adequately protect adjacent property from settlement or loss of lateral support as necessary. Contractor shall comply with all applicable safety laws and building codes to prevent accidents or injury to persons on, about, or adjacent to the Project site where Work is being performed. Contractor shall erect and properly maintain at all times, as required by field conditions and progress of work, all necessary safeguards, signs, barriers, lights, and watchmen for protection of workers and the public, and shall post danger signs warning against hazards created in the course of construction.
- b. In an emergency affecting safety of life or of work or of adjoining property, Contractor, without special instruction or authorization from the Engineer, is hereby permitted to act to prevent such threatened loss or injury; and Contractor shall so act, without appeal, if so authorized or instructed by the Engineer or the City. Any compensation claimed by Contractor on account of emergency work shall be determined by and agreed upon by the City and the Contractor in accordance with ARTICLE 45.
- c. Contractor shall provide such heat, covering, and enclosures as are necessary to protect all Work, materials, equipment, appliances, and tools against damage by weather conditions.
- d. Contractor shall take adequate precautions to protect existing sidewalks, curbs, pavements, utilities, and other adjoining property and structures, and to avoid damage thereto, and Contractor shall repair any damage thereto caused by The Work operations. Contractor shall:
  - 1. Enclose the working area with a substantial barricade, and arrange work to cause minimum amount of inconvenience and danger to the public.



2. Provide substantial barricades around any shrubs or trees indicated to be preserved.
  3. Deliver materials to the Project site over a route designated by the City Traffic Engineer.
  4. Provide any and all dust control required and follow the Applicable air quality regulations as appropriate. If the Contractor does not comply, the City shall have the immediate authority to provide dust control and deduct the cost from payments to the Contractor.
  5. Confine Contractor's apparatus, the storage of materials, and the operations of its workers to limits required by law, ordinances, permits, or directions of the Engineer. Contractor shall not unreasonably encumber the Project site with its materials.
  6. Take care to prevent disturbing or covering any survey markers, monuments, or other devices marking property boundaries or corners. If such markers are disturbed by accident, they shall be replaced by an approved civil engineer or land surveyor, at no cost to the City.
  7. Ensure that existing facilities, fences and other structures are all adequately protected and that, upon completion of all Work, all facilities that may have been damaged are restored to a condition acceptable to the City.
  8. Preserve and protect from injury all buildings, pole lines and all direction, warning and mileage signs that have been placed within the right-of-way.
  9. At the completion of work each day, leave the Project site in a clean, safe condition.
  10. Comply with any stage construction and traffic handling plans. Access to residences and businesses shall be maintained at all times.
  11. These precautionary measures will apply continuously and not be limited to normal working hours. Full compensation for the Work involved in the preservation of life, safety and property as above specified shall be considered as included in the prices paid for the various contract items of Work, and no additional allowance will be made therefor.
- e. Should damage to persons or property occur as a result of The Work, Contractor shall promptly notify the City, in writing. Contractor shall be responsible for proper investigation, documentation, including video or



photography, to adequately memorialize and make a record of what transpired. The City shall be entitled to inspect and copy any such documentation, video, or photographs.

- f. Notwithstanding the foregoing provisions of this article, the Contractor shall not be responsible for the cost of repairing or restoring damage to The Work, which damage is determined to have been proximately caused by an Act of God, in excess of 5 percent of the contracted amount, provided that the work damaged is built in accordance with accepted and applicable building standards and the plans and specifications.

#### **ARTICLE 29. CONTRACTORS MEANS AND METHODS**

Contractor is solely responsible for the means and methods utilized to Perform The Work. In no case shall the Contractor's means and methods deviate from commonly used industry standards.

#### **ARTICLE 30. INSPECTOR'S FIELD OFFICE**

- a. The Contractor shall be responsible for providing the inspector's field office. The Office shall be a substantial waterproof construction with adequate natural light and ventilation by means of stock design windows such as a premanufactured building, modular building or construction trailer. Door shall have a key type lock or padlock clasp. The office shall have heating and air conditioning and shall be equipped with a telephone, a telephone answering machine, high speed internet connection, and Contractor's expense.
- b. A table satisfactory for the study of plans and two chairs shall be Provided by Contractor. Contractor shall Provide and pay for adequate electric lights, local telephone service, and adequate heat and air conditioning for the field office until authorized removal.

#### **ARTICLE 31. AUTHORIZED REPRESENTATIVES**

The City shall designate representatives, who shall have the right to be present at the Project site at all times. The City may designate an inspector who shall have the right to observe all of the Contractor's Work. The inspector is not authorized to make changes in the Contract Documents or excuse Contractor from performing in accordance with the Contract Documents. The inspector shall not be responsible for the Contractor's failure to carry out The Work in accordance with the Contract Documents. Contractor shall provide safe and proper facilities for such access.

#### **ARTICLE 32. HOURS OF WORK**

- a. Eight (8) hours of work shall constitute a legal day's work. The Contractor and each subcontractor shall forfeit, as penalty to the City, twenty-five dollars (\$25) for each worker employed in the execution of Work by the



Contractor or any subcontractor for each day during which such worker is required or permitted to work more than eight (8) hours in any one day and forty (40) hours in any week in violation of the provisions of the Labor Code, and in particular, Section 1810 to Section 1815, except as provided in Labor Code Section 1815.

- b. The Contractor and every subcontractor shall keep an accurate record showing the name of and actual hours worked each calendar day and each calendar week by each worker employed in connection with the Work or any part of the Work contemplated by this Contract. The record shall be kept open at all reasonable hours to the inspection of the City and to the Division of Labor Law Enforcement, Department of Industrial Relations of the State of California.
- c. Work shall be accomplished on a regularly scheduled eight (8) hour per day work shift basis, Monday through Friday, between the hours of 7:00 am and 5:00 pm.
- d. It shall be unlawful for any person to operate, permit, use, or cause to operate any of the following at the Project site, other than between the hours of 7:00 am to 5:00 pm, Monday through Friday, with no Work allowed on City-observed holidays, unless otherwise Approved by the Engineer:
  - 1. Powered Vehicles
  - 2. Construction Equipment
  - 3. Loading and Unloading Vehicles
  - 4. Domestic Power Tool.

### **ARTICLE 33. CITY RECOGNIZED HOLIDAYS**

Work shall not be performed on recognized City Holidays or Holiday closures unless otherwise approved by the Engineer.

Holidays observed by the City are listed below. If any holiday listed falls on a Saturday, the Saturday and the preceding Friday are both legal holidays. If the holiday falls on a Sunday, both Sunday and the following Monday will be legal holidays:

<b><u>Holiday</u></b>	<b><u>Observance Date</u></b>
New Year's Day	January 1 <sup>st</sup>
Martin Luther King Day	3 <sup>rd</sup> Monday in January
Presidents Day	3 <sup>rd</sup> Monday in February
Memorial Day	Last Monday in May
Independence Day	July 4 <sup>th</sup>
Labor Day	1 <sup>st</sup> Monday in September



Veteran's Day	November 11 <sup>th</sup>
Thanksgiving Day	4 <sup>th</sup> Thursday in November
Day After Thanksgiving Day	4 <sup>th</sup> Friday in November
City Holiday Closure*	Christmas Eve through New Year's Day
Christmas Eve	December 24 <sup>th</sup>
Christmas Day	December 25 <sup>th</sup>

#### **ARTICLE 34. WORK DURING ELECTRIION YEAR**

On an election year, road or lane closures shall not be permitted on the first Monday of November and on election day unless otherwise approved by the Engineer. Work may continue during this time only with prior approval by the Engineer.

#### **ARTICLE 35. PAYROLL RECORDS; LABOR COMPLIANCE**

- a. Pursuant to Labor Code Section 1776, the Contractor and each subcontractor shall maintain weekly certified payroll records showing the name, address, social security number, work classification, straight time and overtime hours paid each day and week, and the actual per diem wages paid to each journeyman, apprentice, worker or other employee employed in connection with the work. Contractor shall certify under penalty of perjury that records maintained and submitted by Contractor are true and accurate. Contractor shall also require subcontractor(s) to certify weekly payroll records under penalty of perjury.
- b. In accordance with Labor Code section 1771.4, the Contractor and each subcontractor shall furnish the certified payroll records directly to the Department of Industrial Relations ("DIR") on a weekly basis and in the format prescribed by the DIR, which may include electronic submission. Contractor shall comply with all requirements and regulations from the DIR relating to labor compliance monitoring and enforcement.
- c. Any stop orders issued by the Department of Industrial Relations against Contractor or any subcontractor that affect Contractor's performance of Work, including any delay, shall be Contractor's sole responsibility. Any delay arising out of or resulting from such stop orders shall be considered Contractor caused delay subject to any applicable liquidated damages and shall not be compensable by the City. Contractor shall defend, indemnify and hold the City, its officials, officers, employees and agents free and harmless from any claim or liability arising out of stop orders issued by the Department of Industrial Relations against Contractor or any subcontractor.
- d. The payroll records described herein shall be certified and submitted by the Contractor at a time designated by the City. The Contractor shall also provide the following:



1. A certified copy of the employee's payroll records shall be made available for inspection or furnished to such employee or their authorized representative on request.
  2. A certified copy of all payroll records described herein shall be made available for inspection or furnished upon request of the DIR.
- e. Unless submitted electronically, the certified payroll records shall be on forms provided by the Division of Labor Standards Enforcement ("DLSE") of the DIR or shall contain the same information as the forms provided by the DLSE.
  - f. Any copy of records made available for inspection and furnished upon request to the public or any public agency, the Authority, the Division of Apprenticeship Standards or the Division of Labor Standards Enforcement shall be marked or obliterated in such a manner as to prevent disclosure of an individual's name, address, and social security number. The name and address of the Contractor or any subcontractor shall not be marked or obliterated.
  - g. In the event of noncompliance with the requirements of this Section, the Contractor shall have ten (10) days in which to comply subsequent to receipt of written notice specifying any item or actions necessary to ensure compliance with this section. Should noncompliance still be evident after such ten (10) day period, the Contractor shall, as a penalty to the City, forfeit One Hundred Dollars (\$100.00) for each day, or portion thereof, for each worker until strict compliance is effectuated. Upon the request of the DIR, such penalties shall be withheld from contract payments.
  - h. Pursuant to Labor Code sections 1725.5 and 1771.1, the Contractor and its subcontractors must be registered with the Department of Industrial Relations prior to the execution of a contract to perform public works. By entering into this Contract, Contractor represents that it is aware of the registration requirement and is currently registered with the DIR. Contractor shall maintain a current registration for the duration of the Project. Contractor shall further include the requirements of Labor Code sections 1725.5 and 1771.1 in any subcontract and ensure that all subcontractors are registered at the time this Contract is entered into and maintain registration for the duration of the Project. Notwithstanding the foregoing, the contractor registration requirements mandated by Labor Code Sections 1725.5 and 1771.1 shall not apply to work performed on a public works project that is exempt pursuant to the small project exemption specified in Labor Code Sections 1725.5 and 1771.1.
  - i. The responsibility for compliance with this Article shall rest upon the Contractor.



## **ARTICLE 36. PREVAILING RATES OF WAGES**

- a. The Contractor is aware of the requirements of Labor Code Sections 1720 et seq. and 1770 et seq., as well as California Code of Regulations, Title 8, Section 16000 et seq. ("Prevailing Wage Laws"), which require the payment of prevailing wage rates and the performance of other requirements on certain "public works" and "maintenance" projects. Since this Project involves an applicable "public works" or "maintenance" project, as defined by the Prevailing Wage Laws, and since the total compensation is \$1,000 or more, Contractor agrees to fully comply with such Prevailing Wage Laws. The Contractor shall obtain a copy of the prevailing rates of per diem wages at the commencement of this Agreement from the website of the Division of Labor Statistics and Research of the Department of Industrial Relations located at [www.dir.ca.gov/dlsr/](http://www.dir.ca.gov/dlsr/). In the alternative, the Contractor may view a copy of the prevailing rates of per diem wages at the City. Contractor shall make copies of the prevailing rates of per diem wages for each craft, classification or type of worker needed to perform work on the Project available to interested parties upon request, and shall post copies at the Contractor's principal place of business and at the Project site. Contractor shall defend, indemnify and hold the City, its elected officials, officers, employees and agents free and harmless from any claims, liabilities, costs, penalties or interest arising out of any failure or allege failure to comply with the Prevailing Wage Laws.
- b. The Contractor and each subcontractor shall forfeit as a penalty to the City not more than Two Hundred dollars (\$200) for each Day, or portion thereof, for each worker paid less than the stipulated prevailing wage rate for any work done by him, or by any subcontract under him, in violation of the provisions of the Labor Code. The difference between such stipulated prevailing wage rate and the amount paid to each worker for each Day or portion thereof for which each worker was paid less than the stipulated prevailing wage rate shall be paid to each worker by the Contractor.
- c. Contractor shall post, at appropriate conspicuous points on the Project site, a schedule showing all determined general prevailing wage rates and all authorized deductions, if any, from unpaid wages actually earned.

## **ARTICLE 37. EMPLOYMENT OF APPRENTICES**

The Contractor's attention is directed to the provisions of Sections 1777.5, 1777.6, and 1777.7 of the Labor Code concerning employment of apprentices by the Contractor or any subcontractor. The Contractor shall obtain a certificate of apprenticeship before employing any apprentice pursuant to Section 1777.5, 1777.6, and 1777.7 of the Labor Code. Information relative to apprenticeship standards, wage schedules, and other requirements may be obtained from the Director of Industrial Relations, the Administrator of Apprenticeships, San Francisco, California, or from the Division of Apprenticeship Standards and its branch offices.



## **ARTICLE 38. NONDISCRIMINATION/EQUAL EMPLOYMENT OPPORTUNITY**

Pursuant to Labor Code Section 1735 and other applicable provisions of law, the Contractor and its subcontractors shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, national origin, age, political affiliation, marital status, or handicap on this Project. The Contractor will take affirmative action to insure that employees are treated during employment or training without regard to their race, color, religion, sex, national origin, age, political affiliation, marital status, or handicap.

## **ARTICLE 39. LABOR/EMPLOYMENT SAFETY**

The Contractor shall maintain emergency first aid treatment for their employees which complies with the Federal Occupational Safety and Health Act of 1970 (29 U.S.C. § 651 et seq.), and California Code of Regulations, Title 8, Industrial Relations Division 1, Department of Industrial Relations, Chapter 4. Contractor certifies that it is aware of and has complied with the provisions of California Labor Code section 5401.7, which requires every employer to adopt a written injury and illness prevention program.

## **ARTICLE 40. INSURANCE**

The Contractor shall obtain, and at all times during performance of the Work under these Contract Documents, maintain all of the insurance described in this ARTICLE 38. Contractor shall not commence Work under these Contract Documents until it has provided evidence satisfactory to the City that it has secured all insurance required hereunder. Contractor shall not allow any subcontractor to commence work on any subcontract until it has provided evidence satisfactory to the City that the subcontractor has secured all insurance required under this section. Failure to provide and maintain all required insurance shall be grounds for the City to terminate this Contract for cause. Contractor shall furnish City with original certificates of insurance and endorsements effective coverage required by this Contract on forms satisfactory to the City. The certificates and endorsements for each insurance policy shall be signed by a person authorized by that insurer to bind coverage on its behalf, and shall be on forms acceptable to the City. All certificates and endorsements must be received and approved by the City before Work commences.

- a. **Workers' Compensation Insurance.** The Contractor shall provide workers' compensation insurance for all of the employees engaged in Work under this Contract, on or at the Project site, and, in case any of sublet Work, the Contractor shall require the subcontractor similarly to provide workers' compensation insurance for all the latter's employees as prescribed by State law. Any class of employee or employees not covered by a subcontractor's insurance shall be covered by the Contractor's insurance. In case any class of employees engaged in work under this Contract, on or at the Project site, is not protected under the Workers' Compensation Statutes, the Contractor shall provide or shall cause a subcontractor to provide, adequate insurance coverage for the protection of



such employees not otherwise protected. The Contractor is required to secure payment of compensation to their employees in accordance with the provisions of Section 3700 of the Labor Code. The Contractor shall file with the City certificates of his insurance protecting workers. Company or companies providing insurance coverage shall be acceptable to the City, if in the form and coverage as set forth in the Contract Documents.

- b. **Employer's Liability Insurance.** Contractor shall provide Employer's Liability Insurance, including Occupational Disease, in the amount of at least one million dollars (\$1,000,000) per person per accident. Contractor shall provide City with a certificate of Employer's Liability Insurance. Such insurance shall comply with the provisions of the Contract Documents. The policy shall be endorsed, if applicable, to provide a Borrowed Servant/Alternate Employer Endorsement and contain a Waiver of Subrogation in favor of the City.
- c. **Commercial General Liability Insurance.** Contractor shall provide "occurrence" form Commercial General Liability Insurance coverage at least as broad as the most current ISO CAL Form 00 01, including but not limited to, premises liability, contractual liability, products/completed operations, personal and advertising injury which may arise from or out of Contractor's operations, use, and management of the Project site, or the performance of its obligations hereunder. The policy shall not contain any exclusion contrary to this Contract including but not limited to endorsements or provisions limiting coverage for (1) contractual liability (including but not limited to ISO CG 24 26 or 21 39); or (2) cross-liability for claims or suits against one insured against another. Policy limits shall not be less than \$5,000,000 per occurrence, \$10,000,000 aggregate for bodily injury, personal injury and property damage. If Commercial General Liability Insurance or other form with a general aggregate limit is used, either the general aggregate limit shall apply separately to this Project/location or the general aggregate limit shall be twice the required occurrence limit. Defense costs shall be paid in addition to the limits.
  - 1. Such policy shall comply with all the requirements of this Article. The limits set forth herein shall apply separately to each insured against whom claims are made or suits are brought except with respect to the limits of liability. Further, the limits set forth herein shall not be construed to relieve the Contractor from liability in excess of such coverage, nor shall it limit Contractor's indemnification obligations to the City, and shall not preclude the City from taking such other actions available to the City under other provisions of the Contract Documents or law.
  - 2. All general liability policies provided pursuant to the provisions of this Article shall comply with the provisions of the Contract Documents.



3. All general liability policies shall be written to apply to all bodily injury, including death, property damage, personal injury, owned and non-owned equipment, blanket contractual liability, completed operations liability, explosion, collapse, underground excavation, removal of lateral support, and other covered loss, however occasioned, occurring during the policy term, and shall specifically insure the performance by Contractor of that part of the indemnification contained in these General Conditions relating to liability for injury to or death of persons and damage to property.
  4. If the coverage contains one or more aggregate limits, a minimum of 50% of any such aggregate limit must remain available at all times; if over 50% of any aggregate limit has been paid or reserved, the City may require additional coverage to be purchased by Contractor to restore the required limits. Contractor may combine primary, umbrella, and as broad as possible excess liability coverage to achieve the total limits indicated above. Any umbrella or excess liability policy shall include the additional insured endorsement described in the Contract Documents.
  5. All policies of general liability insurance shall permit and Contractor does hereby waive any right of subrogation which any insurer of Contractor may acquire from Contractor by virtue of the payment of any loss.
- d. **Automobile Liability Insurance.** Contractor shall provide "occurrence" form Automobile Liability Insurance at least as broad as ISO CA 00 01 (Any Auto) in the amount of, at least, one million dollars (\$1,000,000) per accident for bodily injury and property damage. Such insurance shall provide coverage with respect to the ownership, operation, maintenance, use, loading or unloading of any auto owned, leased, hired or borrowed by Contractor or for which Contractor is responsible, in a form and with insurance companies acceptable to the City. All policies of automobile insurance shall permit and Contractor does hereby waive any right of subrogation which any insurer of Contractor may acquire from Contractor by virtue of the payment of any loss.
- e. **Builder's Risk ("All Risk")**
1. It is the Contractor's responsibility to maintain or cause to be maintained Builder's Risk ["All Risk"] extended coverage insurance on all work, material, equipment, appliances, tools, and structures that are or will become part of the Work and subject to loss or damage by fire, and vandalism and malicious mischief, in an amount to cover 100% of the replacement cost. The City accepts no responsibility for the Work until the Work is formally accepted by the



City. The Contractor shall provide a certificate evidencing this coverage before commencing performance of the Work.

2. The named insureds shall be Contractor, all Subcontractors of any tier (excluding those solely responsible for design work), suppliers, and City, its officers, officials, members of the City Council, employees, agents and authorized volunteers, as their interests may appear. Contractor shall not be required to maintain property insurance for any portion of the Work following acceptance by City.
  3. Policy shall be provided for replacement value on an "all risk" basis. There shall be no coinsurance penalty provision in any such policy. Policy must include: (1) coverage for any ensuing loss from faulty workmanship, nonconforming work, omission or deficiency in design or specifications; (2) coverage against machinery accidents and operational testing; (3) coverage for removal of debris, and insuring the buildings, structures, machinery, equipment, materials, facilities, fixtures and all other properties constituting a part of the Project; (4) transit coverage, including ocean marine coverage (unless insured by the supplier), with sub-limits sufficient to insure the full replacement value of any key equipment item; and (5) coverage with sub-limits sufficient to insure the full replacement value of any property or equipment stored either on or off the Site. Such insurance shall be on a form acceptable to City to ensure adequacy and sublimit.
  4. In addition, the policy shall meet the following requirements:
    - (a) Insurance policies shall be so conditioned as to cover the performance of any extra work performed under the Contract.
    - (b) Coverage shall include all materials stored on site and in transit.
    - (c) Coverage shall include Contractor's tools and equipment.
    - (d) Insurance shall include boiler, machinery and material hoist coverage.
- f. **Professional Liability Insurance.** Any architects, engineers, consultants, 3<sup>rd</sup> party geotechnical testing, 3<sup>rd</sup> Party special inspection firms, design professionals retained or employed by Contractor in the performance of the Project shall procure and maintain, for a period of five (5) years following completion of the Contract, errors and omissions liability with a limit of not less than \$1,000,000 per occurrence.



- g. **Contractor's Pollution Liability Coverage.** Contractor shall provide pollution liability insurance in an amount not less than \$1,000,000 per occurrence and \$2,000,000 aggregate.
- h. Contractor shall require all tiers of sub-contractors working under this Contract to provide the insurance required under this ARTICLE 38 unless otherwise agreed to in writing by City. Contractor shall make certain that any and all subcontractors hired by Contractor are insured in accordance with this Contract. If any subcontractor's coverage does not comply with the foregoing provisions, Contractor shall indemnify and hold the City harmless from any damage, loss, cost, or expense, including attorneys' fees, incurred by the City as a result thereof.

#### **ARTICLE 41. FORM AND PROOF OF CARRIAGE OF INSURANCE**

- a. Any insurance carrier providing insurance coverage required by the Contract Documents shall be admitted to and authorized to do business in the State of California unless waived, in writing, by the City's Risk Manager. Carrier(s) shall have an A.M. Best rating of not less than an A:VII. Insurance deductibles or self-insured retentions must be declared by the Contractor. At the election of the City, the Contractor shall either 1) reduce or eliminate such deductibles or self-insured retentions, or 2) procure a bond which guarantees payment of losses and related investigations, claims administration, and defense costs and expenses. If umbrella or excess liability coverage is used to meet any required limit(s) specified herein, the Contractor shall provide a "follow form" endorsement satisfactory to the City indicating that such coverage is subject to the same terms and conditions as the underlying liability policy.
- b. Each insurance policy required by this Contract shall be endorsed to state that: (1) coverage shall not be suspended, voided, reduced or cancelled except after thirty (30) days prior written notice by certified mail, return receipt requested, has been given to the City; and (2) any failure to comply with reporting or other provisions of the policies, including breaches of warranties, shall not affect coverage provided to the City, its directors, officials, officers, employees, agents and volunteers.
- c. The City, its Officers, members of the City Council, employees and authorized volunteers shall be named as Additional Insureds on Contractor's All Risk policy and on Contractor's and its subcontractors' policies of Commercial General Liability and Automobile Liability insurance using, for Contractor's policy/ies of Commercial General Liability insurance, ISO CG forms 20 10 and 20 37 (or endorsements providing the exact same coverage, including completed operations), and, for subcontractors' policies of Commercial General Liability insurance, ISO CG form 20 38 (or endorsements providing the exact same coverage). Notwithstanding the minimum limits set forth in this Contract for any type of insurance coverage,



all available insurance proceeds in excess of the specified minimum limits of coverage shall be available to the parties required to be named as Additional Insureds hereunder. Contractor and its insurance carriers shall provide a Waiver of Subrogation in favor of those parties.

- d. The Certificate(s) and policies of insurance shall contain or shall be endorsed to contain the covenant of the insurance carrier(s) that it shall provide no less than thirty (30) days written notice to be given to the City prior to any material modification or cancellation of such insurance. In the event of a material modification or cancellation of coverage, the City may terminate the Contract or stop the Work in accordance with the Contract Documents, unless the City receives, prior to such effective date, another properly executed original Certificate of Insurance and original copies of endorsements or certified original policies, including all endorsements and attachments thereto evidencing coverage's set forth herein and the insurance required herein is in full force and effect. Contractor shall not take possession, or use the Site, or commence operations under this Contract until the City has been furnished original Certificate(s) of Insurance and certified original copies of endorsements or policies of insurance including all endorsements and any and all other attachments as required in this section. The original endorsements for each policy and the Certificate of Insurance shall be signed by an individual authorized by the insurance carrier to do so on its behalf.
- e. The Certificate(s) of Insurance, policies and endorsements shall so covenant and shall be construed as primary, and the City's insurance and/or deductibles and/or self-insured retentions or self-insured programs shall not be construed as contributory.
- f. The City reserves the right to adjust the monetary limits of insurance coverages during the term of this Contract including any extension thereof if in the City's reasonable judgment, the amount or type of insurance carried by the Contractor becomes inadequate.
- g. Contractor shall report to the City, in addition to Contractor's insurer, any and all insurance claims submitted by the Contractor in connection with the Work under this Contract.

#### **ARTICLE 42. TIME FOR COMPLETION AND LIQUIDATED DAMAGES**

- a. **Time for Completion/Liquidated Damages.** Work shall be commenced within ten (10) days of the date stated in the City's Notice to Proceed and shall be completed by Contractor in the Contract Time. The City is under no obligation to consider early completion of the Project; and the Contract completion date shall not be amended by the City's receipt or acceptance of the Contractor's proposed earlier completion date. Furthermore, Contractor shall not, under any circumstances, receive additional



compensation from the City (including but not limited to indirect, general, administrative or other forms of overhead costs) for the period between the time of earlier completion proposed by the Contractor and the Contract completion date. If The Work is not completed within the Contract Time, it is understood that the City will suffer damage. In accordance with Government Code section 53069.85, being impractical and infeasible to determine the amount of actual damage, it is agreed that Contractor shall pay to the City as fixed and liquidated damages, and not as a penalty, the sum stipulated in the Contract for each day of delay until The Work is fully completed. Contractor and its surety shall be liable for any liquidated damages. Any money due or to become due the Contractor may be retained to cover liquidated damages.

- b. **Inclement Weather.** Contractor shall abide the Engineer's determination of what constitutes inclement weather. Time extensions for inclement weather shall only be granted when the Work stopped during inclement weather is on the critical path of the then-current Project schedule.
- c. **Extension of Time.** Contractor shall not be charged liquidated damages because of any delays in completion of The Work due to unforeseeable causes beyond the control and without the fault or negligence of Contractor (or its subcontractors or suppliers). Contractor shall within five (5) Days of identifying any such delay notify the City in writing of causes of delay. The City shall ascertain the facts and extent of delay and grant extension of time for completing The Work when, in its judgment, the facts justify such an extension. Time extensions to the Project shall be requested by the Contractor as they occur and without delay. No delay claims shall be permitted unless the event or occurrence delays the completion of the Project beyond the Contract completion date.
- d. **No Damages for Reasonable Delay.** The City's liability to Contractor for delays for which the City is responsible shall be limited to only an extension of time unless such delays were unreasonable under the circumstances. In no case shall the City be liable for any costs which are borne by the Contractor in the regular course of business, including, but not limited to, home office overhead and other ongoing costs. Damages caused by unreasonable City delay, including delays caused by items that are the responsibility of the City pursuant to Government Code section 4215, shall be based on actual costs only, no proportions or formulas shall be used to calculate any delay damages.

#### **ARTICLE 43. COST BREAKDOWN AND PERIODIC ESTIMATES**

Contractor shall furnish on forms Approved by the City:



- a. Within ten (10) Days of award of the Contract, a detailed Schedule of Values giving a complete breakdown of the Contract price. The Schedule of Values shall be adjusted as directed by the City.
- b. A monthly itemized estimate of Work done for the purpose of making progress payments. In order for the City to consider and evaluate each progress payment application, the Contractor shall submit a detailed measurement of Work performed and a progress estimate of the value thereof before the tenth (10th) Day of the following month.
- c. Contractor shall submit, with each of its payment requests, an adjusted list of actual quantities, verified by the Engineer, for unit price items listed, if any, in the Bid Form.
- d. Following the City's Acceptance of the Work, the Contractor shall submit to the City a written statement of the final quantities of unit price items for inclusion in the final payment request.
- e. The City shall have the right to adjust any estimate of quantity and to subsequently correct any error made in any estimate for payment.

Contractor shall certify under penalty of perjury, that all cost breakdowns and periodic estimates accurately reflect the Work on the Project.

#### **ARTICLE 44. MOBILIZATION**

- a. When a bid item is included in the Bid Form for mobilization, the costs of Work in advance of construction operations and not directly attributable to any specific bid item will be included in the progress estimate ("Initial Mobilization"). When no bid item is provided for "Initial Mobilization," payment for such costs will be deemed to be included in the other items of The Work.
- b. Payment for Initial Mobilization shall be based on the lump sum provided in the Bid Form, which shall constitute full compensation for all such Work. No payment for Initial Mobilization will be made until all of the listed items have been completed to the satisfaction of the Engineer. The scope of the Work included under Initial Mobilization shall include, but shall not be limited to, the following principal items:
  - 1. Obtaining and paying for all bonds, insurance, and permits.
  - 2. Moving on to the Project site of all Contractor's plant and equipment required for first month's operations.
  - 3. Installing temporary construction power, wiring, and lighting facilities and obtain all necessary permits and service orders from San Diego Gas and Electric.



4. Establishing fire protection system.
5. Developing and installing a construction water supply. Developing and installing a construction water supply as approved by the Padre Dam Municipal Water District.
6. Providing all required electrical, potable water, sewer, communications and all related utility services during the project until project acceptance at the sole cost of the Contractor.
7. Providing and maintaining the field office trailers for the Contractor and the Engineer, complete, with all specified furnishings and utility services including telephones, telephone appurtenances, computer and printer, and copying machine.
8. Providing on-site communication facilities for the Owner and the Engineer, including telephones, high speed internet, radio pagers, and fax machines.
9. Providing on-site sanitary facilities and potable water facilities as specified per Cal-OSHA and these Contract Documents.
10. Furnishing, installing, and maintaining all storage buildings or sheds required for temporary storage of products, equipment, or materials that have not yet been installed in the Work. All such storage shall meet manufacturer's specified storage requirements, and the specific provisions of the specifications, including temperature and humidity control, if recommended by the manufacturer, and for all security.
11. Arranging for and erection of Contractor's work and storage yard.
12. Posting all OSHA required notices and establishment of safety programs per Cal-OSHA.
13. Project Signs
14. 6' tall construction fencing around the project perimeter for the duration of the project.
15. Full-time presence of Contractor's superintendent at the job site as required herein.
16. Submittal of Construction Schedule as required by the Contract Documents.



## **ARTICLE 45.            PAYMENTS**

- a.     The City shall make monthly progress payments following receipt of undisputed and properly submitted payment requests. Contractor shall be paid a sum equal to ninety-five percent (95%) of the value of Work performed up to the last day of the previous month, less the aggregate of previous payments. If the City has made a determination that the Project is substantially complex pursuant to Public Contract Code section 7201, the Contractor shall instead be paid a sum equal to ninety percent (90%) of the value of Work performed up to the last day of the previous month, less the aggregate of previous payments.
- b.     The Contractor shall, after the full completion of The Work, submit a final payment application. All prior progress estimates shall be subject to correction in the final estimate and payment.
- c.     Unless otherwise required by law, the final payment of five percent (5%) of the value of the Work, or ten percent (10%) of the value of the Work where the City has adopted a finding that the Project is substantially complex, if unencumbered, shall be paid no later than sixty (60) Days after the date of recordation of the Notice of Completion.
- d.     Acceptance by Contractor of the final payment shall constitute a waiver of all claims against the City arising from this Contract.
- e.     Payments to the Contractor shall not be construed to be an acceptance of any defective work or improper materials, or to relieve the Contractor of its obligations under the Contract Documents.
- f.     The Contractor shall submit with each payment request the Contractor's conditional waiver of lien for the entire amount covered by such payment request, as well as a valid unconditional waiver of lien from the Contractor and all subcontractors and materialmen for all work and materials included in any prior invoices. Waivers of lien shall be in the forms prescribed by California Civil Code Sections 8132, 8136, and 8138. Prior to final payment by the City, the Contractor shall submit a final conditional waiver of lien for the Contractor's work, together with unconditional releases of lien from any subcontractor or materialmen.

## **ARTICLE 46.            PAYMENTS WITHHELD AND BACKCHARGES**

In addition to amounts which the City may retain under other provisions of the Contract Documents the City may withhold payments due to Contractor as the City may consider to be necessary to cover:

- a.     Stop Notice Claims.
- b.     Defective work not remedied.



- c. Failure of Contractor to make proper payments to its subcontractors or suppliers.
- d. Completion of the Contract if there exists a reasonable doubt that the work can be completed for balance then unpaid.
- e. Damage to another contractor or third party.
- f. Amounts which may be due the City for claims against Contractor.
- g. Failure of Contractor to keep the record ("as-built") drawings up to date.
- h. Failure to provide updates on the construction schedule.
- i. Site cleanup.
- j. Failure of the Contractor to comply with requirements of the Contract Documents.
- k. Liquidated damages.
- l. Legally permitted penalties.

Upon completion of the Contract, the City will reduce the final Contract amount to reflect costs charged to the Contractor, back charges or payments withheld pursuant to the Contract Documents.

#### **ARTICLE 47. CHANGES AND EXTRA WORK**

- a. Change Order Work.
  - 1. The City, without invalidating the Contract, may order changes in the Work consisting of additions, deletions or other revisions, the Contract Price and Contract Time being adjusted accordingly. All such changes in the Work shall be authorized by Change Order, and shall be performed under the applicable conditions of the Contract Documents. A Change Order signed by the Contractor indicates the Contractor's agreement therewith, including any adjustment in the Contract amount or the Contract time, and the full and final settlement of all costs (direct, indirect and overhead) related to the Work authorized by the Change Order.
  - 2. Contractor shall promptly execute changes in the Work as directed in writing by the City even when the parties have not reached agreement on whether the change increases the scope of Work or affects the Contract Price or Contract Time. All claims for additional compensation to the Contractor shall be presented in writing. No claim will be considered after the work in question has been done



unless a written contract change order has been issued or a timely written notice of claim has been made by Contractor. Contractor shall not be entitled to claim or bring suit for damages, whether for loss of profits or otherwise, on account of any decrease or omission of any item or portion of Work to be done. Whenever any change is made as provided for herein, such change shall be considered and treated as though originally included in the Contract, and shall be subject to all terms, conditions and provisions of the original Contract.

3. Owner Initiated Change. The Contractor must submit a complete cost proposal, including any change in the Contract time, within seven (7) Days after receipt of a scope of a proposed change order initiated by the City, unless the City requests that proposals be submitted in less than seven (7) Days.
4. Contractor Initiated Change. The Contractor must give written notice of a proposed change order required for compliance with the Contract Documents within seven (7) Days of discovery of the facts giving rise to the proposed change order.
5. Whenever possible, any changes to the Contract amount shall be in a lump sum mutually agreed to by the Contractor and the City.
6. Price quotations from the Contractor shall be accompanied by sufficiently detailed supporting documentation to permit verification by the City, including but not limited to estimates and quotations from subcontractors or material suppliers, as City may reasonably request.
7. If the Contractor fails to submit a complete cost proposal within the seven (7) Day period (or as requested), the City has the right to order the Contractor in writing to commence the work immediately on a force account basis and/or issue a lump sum change to the Contract Price and/or Contract Time in accordance with the City's estimate. If the change is issued based on the City's estimate, the Contractor will waive its right to dispute the action unless within fifteen (15) Days following completion of the added/deleted work, the Contractor presents written proof that the City's estimate was in error.
8. Unit Price Change Orders.
  - (a) When the actual quantity of a unit price item varies from the Bid Form, compensation for the change in quantity will be calculated by multiplying the actual quantity by the Unit Price. This calculation may result in either an additive or deductive Change Order pursuant to the Contract Documents.



- (b) Since the Contract Unit Prices provided by in the Bid Form include Overhead and Profit as determined by Contractor at time of Bid submission, no mark up or deduction for Overhead and Profit will be included in Unit Price Change Orders.
- 9. Lump Sum and Time & Materials Change Orders. Estimates for lump sum quotations and accounting for cost-plus-percentage work shall be limited to direct expenditures necessitated specifically by the subject extra work, and shall be segregated as follows:
  - (a) Labor. The costs of labor will be the actual cost for wages prevailing locally for each craft or type of worker at the time the extra work is done, plus employer payments of payroll taxes and insurance, health and welfare, pension, vacation, apprenticeship funds, and other direct costs resulting from Federal, State or local laws, as well as assessment or benefits required by lawful collective bargaining agreements. The use of a labor classification which would increase the extra work cost will not be permitted unless the contractor establishes the necessity for such additional costs. Labor costs for equipment operators and helpers shall be reported only when such costs are not included in the invoice for equipment rental.
  - (b) Materials. The cost of materials reported shall be at invoice or lowest current price at which such materials are locally available in the quantities involved, plus sales tax, freight and delivery. Materials cost shall be based upon supplier or manufacturer's invoice. If invoices or other satisfactory evidence of cost are not furnished within fifteen (15) Days of delivery, then the Engineer shall determine the materials cost, at its sole discretion.
  - (c) Tool and Equipment Use. Costs for the use of small tools, tools which have a replacement value of \$1,000 or less shall be considered included in the markups described below. Regardless of ownership, the rates to be used in determining equipment use costs shall not exceed listed rates prevailing locally at equipment rental agencies, or distributors, at the time the work is performed.
  - (d) Overhead, Profit and Other Charges. The mark-up for overhead (including supervision) and profit on work added to the Contract shall be according to the following:
    - (1) "Net Cost" is defined as consisting of costs of labor, materials and tools and equipment only excluding overhead and profit. The costs of applicable insurance



and bond premium will be reimbursed to the Contractor and subcontractors at cost only, without mark-up. Contractor shall provide City with documentation of the costs, including but not limited to payroll records, invoices and such other information as City may reasonably request.

- (2) For Work performed by the Contractor's forces, the added cost for overhead and profit shall not exceed ten (10%) percent of the Net Cost of the Work.
  - (3) For Work performed by a subcontractor, the added cost for overhead and profit shall not exceed ten percent (10%) of the subcontractor's Net Cost of the Work to which the Contractor may add five (5%) percent of the subcontractor's Net Cost.
  - (4) For Work performed by a sub-subcontractor, the added cost for overhead and profit shall not exceed ten (10 %) percent of the sub-subcontractor's Net Cost for Work to which the subcontractor and general contractor may each add an additional five percent (5%) of the Net Cost of the lower tier subcontractor.
  - (5) No additional markup will be allowed for lower tier subcontractors, and in no case shall the added cost for overhead and profit payable by City exceed twenty-five (25%) percent of the Net Cost as defined herein, of the party that performs the Work.
- (e) All of the following costs are included in the markups for overhead and profit described above, and Contractor shall not receive any additional compensation for: Submittals, drawings, field drawings, Shop Drawings, including submissions of drawings; field inspection; General Superintendence; General administration and preparation of cost proposals, schedule analysis, Change Orders, and other supporting documentation; computer services; reproduction services; Salaries of project engineer, superintendent, timekeeper, storekeeper, and secretaries; Janitorial services; Small tools, incidentals and consumables; Temporary On-Site facilities (Offices, Telephones, High Speed Internet Access, Plumbing, Electrical Power, Lighting; Platforms, Fencing, Water), Jobsite and Home office overhead or other expenses; vehicles and fuel used for work otherwise included in the Contract Documents; Surveying; Estimating; Protection of Work; Handling and disposal fees; Final Cleanup; Other



Incidental Work; Related Warranties; insurance and bond premiums.

10. For added or deducted Work by subcontractors, the Contractor shall furnish to the City the subcontractor's signed detailed record of the cost of labor, material and equipment, including the subcontractor markup for overhead and profit. The same requirement shall apply to sub-subcontractors.
11. For added or deducted work furnished by a vendor or supplier, the Contractor shall furnish to the City a detailed record of the cost to the Contractor, signed by such vendor or supplier.
12. Any change in The Work involving both additions and deletions shall indicate a net total cost, including subcontracts and materials. Allowance for overhead and profit, as specified herein, shall be applied if the net total cost is an increase in the Contract Price; overhead and profit allowances shall not be applied if the net total cost is a deduction to the Contract Price. The estimated cost of deductions shall be based on labor and material prices on the date the Contract was executed.
13. Contractor shall not reserve a right to assert impact costs, extended job site costs, extended overhead, constructive acceleration and/or actual acceleration beyond what is stated in the change order for work. No claims shall be allowed for impact, extended overhead costs, constructive acceleration and/or actual acceleration due to a multiplicity of changes and/or clarifications. The Contractor may not change or modify the City's change order form in an attempt to reserve additional rights.
14. If the City disagrees with the proposal submitted by Contractor, it will notify the Contractor and the City will provide its opinion of the appropriate price and/or time extension. If the Contractor agrees with the City, a change order will be issued by the City. If no agreement can be reached, the City shall have the right to issue a unilateral change order setting forth its determination of the reasonable additions or savings in costs and time attributable to the extra or deleted work. Such determination shall become final and binding if the Contractor fails to submit a claim in writing to the City within fifteen (15) Days of the issuance of the unilateral change order, disputing the terms of the unilateral change order, and providing such supporting documentation for its position as the City may require.
15. No dispute, disagreement or failure of the parties to reach agreement on the terms of the change order shall relieve the Contractor from



the obligation to proceed with performance of the work, including extra work, promptly and expeditiously.

16. Any alterations, extensions of time, extra work or any other changes may be made without securing consent of the Contractor's surety or sureties.

b. Changes to Contract Time

1. The Contract Time may only be changed by a Change Order.
2. All changes in the Contract Price and/or adjustments to the Contract Times related to each change shall be included in Contractor's change order proposal described above. All Change Orders must state that the Contract Time is not changed or is either increased or decreased by a specific number of days. Failure to include a change to time shall waive any change to the Contract Time unless the parties mutually agree in writing to postpone a determination of the change to time resulting from the Change Order. No cost or time will be allowed for cumulative effects of multiple changes.
3. Notice of the amount of the request for adjustment in the Contract Time with supporting data shall be delivered within seven (7) Days after such start of occurrence. No extension of time or additional compensation shall be given for a delay if the Contractor failed to give notice in the manner and within the time prescribed.
4. Float is for the benefit of the Project. Float shall not be considered for the exclusive use or benefit of either the City or the Contractor. Any difference in time between the Contractor's early completion and the Contract Time shall be considered a part of the Project float. Contractor shall not be entitled to compensation, and the City will not compensate Contractor, for delays which impact early completion.
5. Contractor's entitlement to an extension of the Contract Time is limited to City-caused extension of the critical path, reduced by the Contractor's concurrent delays, and established by a proper time impact analysis. No time extension shall be allowed unless, and then only to the extent that, the City-caused delay extends the critical path beyond the previously approved Contract Time.
  - (a) Contractor shall not be entitled to an adjustment in the Contract Time for delays within the control of Contractor. Delays attributable to and within the control of a subcontractor or supplier shall be deemed to be delays within the control of Contractor.



- (b) If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions (as determined by the City), Acts of God, acts or failures to act of utility owners not under the control of City, or other causes not the fault of and beyond control of the City and Contractor, then Contractor shall be entitled to an time extension when the affected Work is on the critical path. Such a non-compensable adjustment shall be Contractor's sole and exclusive remedy for such delays. Contractor must submit a timely request in accordance with the requirements of this Article.
- 6. Requests for Time Extension: Contractor's justification for entitlement shall be clear and complete citing specific Contract Document references and reasons on which Contractor's entitlement is based. At a minimum, each request for a time extension must include:
  - (a) Each request for an extension of Contract Time must identify the impacting event, in narrative form, providing a description of the delay event and sufficient justification as to why the Contractor is entitled to a time extension. Contractor must demonstrate that the delay arises from unforeseeable causes beyond the control and without the fault or negligence of both Contractor and any Subcontractors or Suppliers, or any other persons or organizations employed by any of them or for whose acts any of them may be liable, and that such causes in fact lead to performance or completion of the Work, or specified part in question, beyond the corresponding Contract Times, despite Contractor's reasonable and diligent actions to guard against those effects.
  - (b) Each request for an extension of Contract Time must include a time impact analysis in CPM format to calculate the impact of the delay event to the critical path.
- 7. Contractor's failure, neglect, or refusal to comply with these requirements, or any portion thereof, shall bar Contractor's request for extensions of the Contract Time. Such failure, neglect, or refusal prejudices the City's ability to recognize and mitigate delay, and such failure, neglect, or refusal prevent the timely analysis of requests for extensions of Contract Time, and whether such extensions may be warranted. Contractor hereby waives all rights to extensions of Contract Time due to delays or accelerations that result from or occur during periods of time for which Contractor fails, neglects, or refuses to fully comply with the requirements of this Article.



## **ARTICLE 48. OCCUPANCY**

The City reserves the right to occupy or utilize any portion of The Work at any time before completion, and such occupancy or use shall not constitute Acceptance of any part of Work covered by this Contract. This use shall not relieve the Contractor of its responsibilities under the Contract.

## **ARTICLE 49. INDEMNIFICATION**

To the fullest extent allowed by law, Contractor shall defend (with Counsel of City's choosing), indemnify and hold the City, its officers, officials, members of the City Council, employees, agents and authorized volunteers free and harmless from any and all claims, demands, causes of action, costs, expenses, liabilities, losses, damages or injuries, at law or in equity, regardless of whether the allegations are false, fraudulent, or groundless, to property or persons, including wrongful death, to the extent arising out of or incident to any acts, omissions or willful misconduct of Contractor, its officials, officers, employees, agents, consultants and contractors arising out of or in connection with the performance of the Work or this Contract, including claims made by subcontractors for nonpayment, including without limitation the payment of all consequential damages and attorneys fees and other related costs and expenses. Contractor shall defend, at Contractor's own cost, expense and risk, with Counsel of City's choosing, any and all such aforesaid suits, actions or other legal proceedings of every kind that may be brought or instituted against City, its officers, officials, members of the City Council, employees, agents and authorized volunteers. To the extent of its liability, Contractor shall pay and satisfy any judgment, award or decree that may be rendered against City, its officers, officials, members of the City Council, employees, agents, and authorized volunteers in any such suit, action or other legal proceeding. Contractor shall reimburse City, its officers, officials, members of the City Council, employees, agents and authorized volunteers for any and all legal expenses and costs incurred by each of them in connection therewith or in enforcing the indemnity herein provided. The only limitations on this provision shall be those imposed by Civil Code Section 2782.

## **ARTICLE 50. RECORD ("AS BUILT") DRAWINGS**

- a. Contractor shall prepare and maintain a complete set of record drawings (herein referred to as "as-builts") and shall require each trade to prepare its own as-builts. The as-builts must show the entire site for each major trade, including but not limited to water, sewer, electrical, data, telephone, cable, fire alarm, gas and plumbing. Contractor shall mark the as-builts to show the actual installation where the installation varies from the Work as originally shown. Contractor shall mark whichever drawings are most capable of showing conditions fully and where shop drawings are used, Contractor must record a cross-reference at the corresponding location on the contract drawings. Contractor shall give particular attention to concealed elements that would be difficult to measure and record at a later date. Contractor shall use colors to distinguish variations in separate categories of The Work.



- b. Contractor shall note related change order numbers where applicable. Contractor shall organize as-builts into manageable sets, bound with durable paper cover sheets and shall print suitable title, dates and other identification on the cover of each set. Contractor to also provide an electronic version of the as-builts. The suitability of the as-builts will be determined by the Engineer.

## **ARTICLE 51. RESOLUTION OF CONSTRUCTION CLAIMS**

- a. Contractor shall timely comply with all notices and requests for additional compensation and extensions of time, including but not limited to all requirements of Article 45, as a prerequisite to filing any claim governed by this Article. The failure to timely submit a notice of delay or notice of change, or to timely request a change to the Contract Price or Contract Time, or to timely provide any other notice or request required herein shall constitute a waiver of the right to further pursue the claim under the Contract or at law..
- b. **Intent.** Effective January 1, 1991, Section 20104 et seq., of the California Public Contract Code prescribes a process utilizing informal conferences, non-binding judicial supervised mediation, and judicial arbitration to resolve disputes on construction claims of \$375,000 or less. Effective January 1, 2017, Section 9204 of the Public Contract Code prescribes a process for negotiation and mediation to resolve disputes on construction claims. The intent of this Article is to implement Sections 20104 et seq. and Section 9204 of the California Public Contract Code. This Article shall be construed to be consistent with said statutes.
- c. **Claims.** For purposes of this Article, "Claim" means a separate demand by the Contractor, after a change order duly requested in accordance with Article 45 "Changes and Extra Work" has been denied by the City, for (1) a time extension, (2) payment of money or damages arising from Work done by or on behalf of the Contractor pursuant to the Contract, or (3) an amount the payment of which is disputed by the City. Claims governed by this Article may not be filed unless and until the Contractor completes all procedures for giving notice of delay or change and for the requesting of a time extension or change order, including but not necessarily limited to the procedures contained in Article 45, Changes and Extra Work, and Contractor's request for a change has been denied in whole or in part. Claims governed by this Article must be filed no later than the date of final payment. Any claim must be submitted in writing to the City and shall include on its first page the following in 16 point capital font: "THIS IS A CLAIM." Furthermore, the claim shall include the documents necessary to substantiate the claim. Nothing herein is intended to extend the time limit or supersede notice requirements otherwise provided by contract for the filing of claims, including all requirements pertaining to compensation or payment for extra work, disputed work, and/or changed conditions. Failure



to follow such contractual requirements shall bar any claims or subsequent lawsuits for compensation or payment thereon.

d. **Supporting Documentation.** The Contractor shall submit all claims in the following format:

1. Summary of claim merit, price, and time, and Contract Document provisions pursuant to which the claim is made.
2. List of documents relating to claim
  - (a) Specifications
  - (b) Drawings
  - (c) Clarifications (Requests for Information)
  - (d) Schedules
  - (e) Other
3. Chronology of events and correspondence
4. Analysis of claim merit
5. Analysis of claim cost
6. Analysis of time impact analysis in CPM format

e. **City Response to Claim.** Upon receipt of a Claim pursuant to this Article, the City shall conduct a reasonable review of the Claim and, within a period not to exceed 45 days of receipt of the claim, or as extended by mutual agreement, shall provide a written statement identifying what portion of the Claim is disputed and what portion is undisputed. Any payment due on an undisputed portion of the Claim will be processed and made within 60 days after the City issues its written response.

If the City needs approval from the City Council to provide Contractor a written statement as set forth above, and City Council does not meet within the 45 days or within the mutually agreed to extension of time following receipt of a Claim, the City shall have up to three (3) days following the next publicly noticed meeting of City Council after the 45-day period, or extension, expires to provide Contractor a written statement identifying the disputed portion and the undisputed portion of the Claim.



The City may request, in writing, within 30 days of receipt of the claim, any additional documentation supporting the claim or relating to defenses or claims the City may have. If additional information is needed thereafter, it shall be provided upon mutual agreement of the City and the Contractor. The City's written response shall be submitted 30 days (15 days if the Claim is less than \$50,000) after receiving the additional documentation, or within the same period of time taken by the claimant to produce the additional information, whichever is greater.

- f. **Meet and Confer Conference.** If the Contractor disputes the City's written response, or if the City fails to respond within the time prescribed, the Contractor may so notify the City within 15 days of the receipt of the response or the failure to respond, and demand an informal conference to meet and confer for settlement of those portions of the Claim that remain in dispute. Upon receipt of such demand, the City shall schedule a meet and confer conference within 30 Days for settlement of the dispute.
- g. **Mediation.** Within 10 business days following the conclusion of the meet and confer conference, if the claim or any portion thereof remains in dispute, the City shall provide the Contractor with a written statement identifying the portion of the claim that remains in dispute and the portion that is undisputed. Any payment due on an undisputed portion of the claim shall be processed and made within 60 Days after the public entity issues its written statement. Any portion of the claim that remains in dispute shall be submitted to nonbinding mediation and the City and the Contractor shall equally share the associated mediator fees. The City and Contractor shall mutually agree to a mediator within 10 business Days after the disputed portion of the claim has been identified in writing, unless the parties agree to select a mediator at a later time.
  - 1. If the parties cannot agree upon a mediator, each party shall select a mediator and those mediators shall select a qualified neutral third party to mediate with regard to the disputed portion of the claim. Each party shall bear the fees and costs charged by its respective mediator in connection with the selection of the neutral mediator.
  - 2. For purposes of this section, mediation includes any nonbinding process, including, but not limited to, neutral evaluation or a dispute review board, in which an independent third party or board assists the parties in dispute resolution through negotiation or by issuance of an evaluation. Any mediation utilized shall conform to the timeframes in this section.
  - 3. Unless otherwise agreed to by the public entity and the Contractor in writing, the mediation conducted pursuant to this section shall excuse any further obligation under Section 20104.4 to mediate after litigation has been commenced.



4. The mediation shall be held no earlier than the date the Contractor completes the Work or the date that the Contractor last performs Work, whichever is earlier. All unresolved claims shall be considered jointly in a single mediation, unless a new unrelated claim arises after mediation is completed.
- h. **Procedures After Mediation.** If following the mediation, the claim or any portion remains in dispute, the Contractor must file a claim pursuant to Chapter 1 (commencing with Section 900) and Chapter 2 (commencing with Section 910) of Part 3 of Division 3.6 of Title 1 of the Government Code prior to initiating litigation. For purposes of those provisions, the running of the period of time within which a claim must be filed shall be tolled from the time the Contractor submits their written claim pursuant to subdivision (a) until the time the claim is denied, including any period of time utilized by the meet and confer conference.
- i. **Government Code Claim.** In addition to any and all contract requirements pertaining to notices of and requests for compensation or payment for extra work, disputed work, construction claims and/or changed conditions, the Contractor must comply with the claim procedures set forth in Government Code section 900 *et seq.* prior to filing any lawsuit against the City. Such Government Code claims and any subsequent lawsuit based upon the Government Code claims shall be limited to those matters that remain unresolved after all procedures pertaining to extra work, disputed work, construction claims, and/or changed conditions have been followed by Contractor. If no such Government Code claim is submitted, or if the prerequisite contractual requirements are not otherwise satisfied as specified herein, Contractor shall be barred from bringing and maintaining a valid lawsuit against the City. **A Government Code claim must be filed no earlier than the date the Work is completed or the date the Contractor last performs Work on the Project, whichever occurs first. A Government Code claim shall be inclusive of all unresolved claims unless a new unrelated claim arises after the Government Code claim is submitted.**
- j. **Civil Actions.** The following procedures are established for all civil actions filed to resolve claims of \$375,000 or less:
  1. Within 60 Days, but no earlier than 30 Days, following the filing or responsive pleadings, the court shall submit the matter to non-binding mediation unless waived by mutual stipulation of both parties or unless mediation was held prior to commencement of the action in accordance with Public Contract Code section 9204 and the terms of this Agreement. The mediation process shall provide for the selection within 15 Days by both parties of a disinterested third person as mediator, shall be commenced within 30 Days of the submittal, and shall be concluded within 15 Days from the



commencement of the mediation unless a time requirement is extended upon a good cause showing to the court.

2. If the matter remains in dispute, the case shall be submitted to judicial arbitration pursuant to Chapter 2.5 (commencing with Section 1141.10) of Title 3 of Part 3 of the Code of Civil Procedure, notwithstanding Section 1114.11 of that code. The Civil Discovery Act of 1986 (Article 3 (commencing with Section 2016) of Chapter 3 of Title 3 of Part 4 of the Code of Civil Procedure) shall apply to any proceeding brought under this subdivision consistent with the rules pertaining to judicial arbitration. In addition to Chapter 2.5 (commencing with Section 1141.10) of Title 3 of Part 3 of the Code of Civil Procedure, (A) arbitrators shall, when possible, be experienced in construction law, and (B) any party appealing an arbitration award who does not obtain a more favorable judgment shall, in addition to payment of costs and fees under that chapter, also pay the attorney's fees on appeal of the other party.

- k. **Non-Waiver.** The City's failure to respond to a claim from the Contractor within the time periods described in this Article or to otherwise meet the time requirements of this Article shall result in the claim being deemed rejected in its entirety.

## **ARTICLE 52. CITY'S RIGHT TO TERMINATE CONTRACT**

- a. **Termination for Cause:** The City may, without prejudice to any other right or remedy, serve written notice upon Contractor of its intention to terminate this Contract if the Contractor: (i) refuses or fails to prosecute The Work or any part thereof with such diligence as will ensure its completion within the time required; (ii) fails to complete The Work within the required time; (iii) should file a bankruptcy petition or be adjudged a bankrupt; (iv) should make a general assignment for the benefit of its creditors; (v) should have a receiver appointed; (vi) should persistently or repeatedly refuse or fail to supply enough properly skilled workers or proper materials to complete the work; (vii) should fail to make prompt payment to subcontractors or for material or labor; (viii) persistently disregard Applicable Laws, ordinances, other requirements or instructions of the City; or (ix) should violate any of the provisions of the Contract Documents.

The notice of default and intent to terminate shall contain the reasons for termination. Unless within ten (10) Days after the service of such notice, Contractor resolves the circumstances giving rise to the notice of default to the City's satisfaction, or makes arrangements acceptable to the City for the required corrective action, this Contract shall terminate. In such case, Contractor shall not be entitled to receive any further payment until the Project has been finished. The City may take over and complete The Work by any method it may deem appropriate. Contractor and its surety shall be



liable to the City for any excess costs or other damages incurred by the City to complete the Project. If the City takes over The Work, the City may, without liability for so doing, take possession of and utilize in completing The Work such materials, appliances, plant, and other property belonging to the Contractor as may be on the Project site.

- b. **Termination For Convenience:** In addition to its right to terminate this Contract for default, the City may terminate the Contract, in whole or in part, at any time upon ten (10) Days written notice to Contractor. The Notice of Termination shall specify that the termination is for the convenience of the City, the extent of termination and the effective date of such termination.

After receipt of Notice of Termination, and except as directed by the City, the Contractor shall, regardless of any delay in determining or adjusting any amounts due under this Termination for Convenience clause, immediately proceed with the following obligations:

1. Stop Work as specified in the Notice.
2. Complete any Work specified in the Notice of Termination in a least cost/shortest time manner while still maintaining the quality called for under the Contract Documents.
3. Leave the Site and any other property upon which the Contractor was working and upon which the facility (or facilities) forming the basis of the Contract Documents is situated in a safe and sanitary manner such that it does not pose any threat to the public health or safety.
4. Terminate all subcontracts and purchase orders to the extent that they relate to the portions of The Work terminated.
5. Place no further subcontracts or orders, except as necessary to complete the remaining portion of The Work.
6. Submit to the City, within ten (10) Days from the effective date of the Notice of Termination, all of the documentation called for by the Contract Documents to substantiate all costs incurred by the Contractor for labor, materials and equipment through the Effective Date of the Notice of Termination. Any documentation substantiating costs incurred by the Contractor solely as a result of the City's exercise of its right to terminate this Contract pursuant to this clause, which costs the Contractor is authorized under the Contract Documents to incur, shall: (i) be submitted to and received by the City no later than thirty (30) Days after the Effective Date of the Notice of Termination; (ii) describe the costs incurred with



particularity; and (iii) be conspicuously identified as "Termination Costs Occasioned by the City's Termination for Convenience."

7. City's total liability to Contractor by reason of the termination shall be limited to the total (without duplication of any items) of:
  - (a) The reasonable cost to the Contractor for all Work performed prior to the effective date of the termination, determined in accordance with the force account provisions of ARTICLE 45, including the Work done to secure the Project for termination. Reasonable cost may not exceed the applicable percentage completion values derived from the progress schedule and the Cost Breakdown. Deductions shall be made for cost of materials to be retained by the Contractor, cost of Work defectively performed, amounts realized by sale of materials, and for other appropriate credits or offsets against cost of Work as allowed by the Contract Documents. Reasonable cost will include reasonable allowance for Project overhead and general administrative overhead.
  - (b) When, in the City's opinion, the cost of any item of Work is excessively high due to costs incurred to remedy or replace defective or rejected Work, reasonable cost to be allowed will be the estimated reasonable cost of performing the Work in compliance with requirements of the Contract Documents and excessive actual cost shall be disallowed.
  - (c) A reasonable allowance for profit on cost of Work performed as determined in accordance with ARTICLE 45 provided that the Contractor establishes to the City's satisfaction that the Contractor would have made a profit had the Project been completed, and provided further that the profit allowed shall not exceed five percent (5%) percent of the cost.
  - (d) Reasonable costs to the Contractor of handling material returned to vendors, delivered to the City or otherwise disposed of as directed by the City.
  - (e) A reasonable allowance for the Contractor's internal administrative costs in preparing termination claim.
  - (f) Reasonable demobilization costs, and reasonable payments made to Subcontractors or suppliers on account of termination.
8. In no event shall the City be liable for unreasonable costs incurred by the Contractor or subcontractors after receipt of a notice of



termination. Such non-recoverable costs include, but are not limited to, the cost of or anticipated profits on Work not performed as of the date of termination, post-termination employee salaries, unreasonable post-termination administrative expenses, post-termination overhead or unabsorbed overhead, surety costs of any type, costs of preparing and submitting the Contractor's termination claim, attorney fees of any type, and all other costs relating to prosecution of a claim or lawsuit.

9. The City shall have no obligation to pay the Contractor under this ARTICLE 50 (Termination for Convenience) unless and until the Contractor provides the City with updated and acceptable as-builts and Record Documents for Work completed prior to termination.
10. In arriving at the amount due the Contractor under this clause, there shall be deducted in whole or in the appropriate part(s) if the termination is partial.
  - (a) All unliquidated advances or other payments on account previously made to the Contractor, including without limitation all payments which are applicable to the terminated portion of the Contract Documents.
  - (b) Any claim the City may have against the Contractor in connection with the Work, and
  - (c) The agreed price for or proceeds of sale of, any materials, supplies, or other things kept by the Contractor and not otherwise recovered by or credited to the City.

These provisions are in addition to and not in limitation of any other rights or remedies available to the City.

- c. **Savings Clause.** If City terminates Contractor for cause, and if it is later determined that the termination was wrongful, such default termination shall automatically be converted to and treated as a termination for convenience. In such event, Contractor shall be entitled to receive only the amounts payable under this section, and Contractor specifically waives any claim for any other amount or damages, including, but not limited to, any claim for consequential damages or lost profits.
- d. **Exception.** Notwithstanding any other provision of this Article, when immediate action is necessary to protect life and safety or to reduce significant exposure or liability, the City may immediately order Contractor to cease Work until such safety or liability issues are addressed to the satisfaction of the City or the Contract is terminated.



## **ARTICLE 53. WARRANTY AND GUARANTEE**

- a. Contractor warrants that all materials and equipment furnished under this Contract shall be new unless otherwise specified in the Contract Documents; and that all Work conforms to the Contract Document requirements and is free of any defect whether performed by the Contractor or any subcontractor or supplier.
- b. Unless otherwise stated, all warranty periods shall begin upon the filing of the Notice of Completion. Unless otherwise stated, the warranty period shall be for one year.
- c. The Contractor shall remedy at its expense any damage to City-owned or controlled real or personal property.
- d. Contractor shall furnish the City with all warranty and guarantee documents prior to final Acceptance of the Project by the City.
- e. The City shall notify the Contractor, in writing, within a reasonable time after the discovery of any failure, defect, or damage. The Contractor shall within ten (10) Days after being notified commence and perform with due diligence all necessary Work to complete or correct the Work at issue. If the Contractor fails to promptly remedy any defect, or damage; the City shall have the right to replace, repair, or otherwise remedy the defect, or damage at the Contractor's expense.
- f. In the event of any emergency constituting an immediate hazard to health, safety, property, or licensees, when caused by Work of the Contractor not in accordance with the Contract requirements, the City may undertake at Contractor's expense, and without prior notice, all actions necessary to correct such condition.
- g. With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for Work performed and Materials furnished under this Contract, the Contractor shall:
  - 1. Obtain for City all warranties that would be given in normal commercial practice or that are required in the Contract Documents;
  - 2. Require all warranties to be executed, in writing, for the benefit of the City; and
  - 3. Enforce all warranties for the benefit of the City, unless otherwise directed in writing by the City.

This Article shall not limit the City's rights under this Contract or with respect to latent defects, gross mistakes, or fraud. The City specifically reserves all rights related to defective work, including but not limited to the defect claims pursuant to California Code



of Civil Procedure Section 337.15.

#### **ARTICLE 54. DOCUMENT RETENTION & EXAMINATION**

- a. In accordance with Government Code Section 8546.7, records of both the City and the Contractor shall be subject to examination and audit by the State Auditor General for a period of three (3) years after final payment.
- b. Contractor shall make available to the City any of the Contractor's other documents related to the Project immediately upon request of the City.
- c. In addition to the State Auditor rights above, the City shall have the right to examine and audit all books, estimates, records, contracts, documents, bid documents, subcontracts, and other data of the Contractor (including electronic records, computations and projections) related to negotiating, pricing, or performing the modification in order to evaluate the accuracy and completeness of the cost or pricing data at no additional cost to the City, for a period of four (4) years after final payment.

#### **ARTICLE 55. SOILS INVESTIGATIONS**

When a soils investigation report for the Project site is available, such report shall not be a part of the Contract Documents. Any information obtained from such report as to subsurface soil condition, or to elevations of existing grades or elevations of underlying rock, is approximate only and is not guaranteed. Contractor acknowledges that any soils investigation report (including any borings) was prepared for purposes of design only and Contractor is required to examine the site before submitting its bid and must make whatever tests it deems appropriate to determine the underground condition of the soil.

#### **ARTICLE 56. SEPARATE CONTRACTS**

- a. The City reserves the right to let other contracts in connection with this Work or on the Project site. Contractor shall cooperate with and permit other contractors reasonable access and storage of their materials and execution of their work and shall properly connect and coordinate its Work with theirs.
- b. To ensure proper execution of its subsequent Work, Contractor shall immediately inspect work already in place and shall at once report to the Engineer any problems with the work in place or discrepancies with the Contract Documents.
- c. Contractor shall ascertain to its own satisfaction the scope of the Project and nature of any other contracts that have been or may be awarded by the City in prosecution of the Project to the end that Contractor may perform this Contract in the light of such other contracts, if any. Nothing herein contained shall be interpreted as granting to Contractor exclusive occupancy at site of the Project. Contractor shall not cause any



unnecessary hindrance or delay to any other contractor working on the Project. If simultaneous execution of any contract for the Project is likely to cause interference with performance of some other contract or contracts, the Engineer shall decide which Contractor shall cease Work temporarily and which contractor shall continue or whether work can be coordinated so that contractors may proceed simultaneously. The City shall not be responsible for any damages suffered or for extra costs incurred by Contractor resulting directly or indirectly from award, performance, or attempted performance of any other contract or contracts on the Project site.

#### **ARTICLE 57. NOTICE AND SERVICE THEREOF**

All notices shall be in writing and either served by personal delivery or mailed to the other party as designated in the Bid Forms. Written notice to the Contractor shall be addressed to Contractor's principal place of business unless Contractor designates another address in writing for service of notice. Notice to City shall be addressed to the City as designated in the Notice Inviting Bids unless City designates another address in writing for service of notice. Notice shall be effective upon receipt or five (5) Days after being sent by first class mail, whichever is earlier. Notice given by facsimile shall not be effective unless acknowledged in writing by the receiving party.

#### **ARTICLE 58. NOTICE OF THIRD PARTY CLAIMS**

Pursuant to Public Contract Code Section 9201, the City shall provide Contractor with timely notification of the receipt of any third-party claim relating to the Contract.

#### **ARTICLE 59. STATE LICENSE BOARD NOTICE**

Contractors are required by law to be licensed and regulated by the Contractors' State License Board which has jurisdiction to investigate complaints against contractors if a complaint regarding a patent act or omission is filed within four (4) years of the date of the alleged violation. A complaint regarding a latent act or omission pertaining to structural defects must be filed within ten (10) years of the date of the alleged violation. Any questions concerning a contractor may be referred to the Registrar, Contractors' State License Board, P.O. Box 26000, Sacramento, California 95826.

#### **ARTICLE 60. INTEGRATION**

- a. This Contract, together with its incorporated documents, contains the entire, integrated agreement of the parties hereto, and supersedes any and all other prior to contemporaneous negotiations, understandings and oral or written agreements between the parties hereto. Each party acknowledges that no representations, inducements, promises or agreements have been made by any person which are not incorporated herein, and that any other agreements shall be void.



- b. Any modification of this Contract shall be effective in writing signed by all parties hereto. No oral order, objection, direction, claim or notice by any party or person shall affect or modify any of the terms or obligations contained in the Contract Documents.

#### **ARTICLE 61. ASSIGNMENT**

Contractor shall not assign, transfer, convey, sublet, or otherwise dispose of this Contract or any part thereof including any claims, without prior written consent of the City. Any assignment without the written consent of the City shall be void. Any assignment of money due or to become due under this Contract shall be subject to a prior lien for services rendered or Material supplied for performance of Work called for under the Contract Documents in favor of all persons, firms, or corporations rendering such services or supplying such Materials to the extent that claims are filed pursuant to the Civil Code, the Code of Civil Procedure or the Government Code.

#### **ARTICLE 62. CHANGE IN NAME AND NATURE OF CONTRACTOR'S LEGAL ENTITY**

Should a change be contemplated in the name or nature of the Contractor's legal entity, the Contractor shall first notify the City in order that proper steps may be taken to have the change reflected on the Contract and all related documents. No change of Contractor's name or nature will affect City's rights under the Contract, including but not limited to the bonds.

#### **ARTICLE 63. ASSIGNMENT OF ANTITRUST ACTIONS**

Pursuant to Section 7103.5 of the Public Contract Code, in entering into a public works contract or subcontract to supply goods, services, or materials pursuant to a public works contract, Contractor or subcontractor offers and agrees to assign to the City all rights, title, and interest in and to all causes of action it may have under Section 4 of the Clayton Act (15 U.S.C. Section 15) or under the Cartwright Act (chapter 2 (commencing with Section 16700) of part 2 of division 7 of the Business and Professions Code), arising from the purchase of goods, services, or materials pursuant to this Contract or any subcontract. This assignment shall be made and become effective at the time the City makes final payment to the Contractor, without further acknowledgment by the parties.

#### **ARTICLE 64. PROHIBITED INTERESTS**

No City official or representative who is authorized in such capacity and on behalf of the City to negotiate, supervise, make, accept, or approve, or to take part in negotiating, supervising, making, accepting or approving any engineering, inspection, construction or material supply contract or any subcontract in connection with construction of the project, shall be or become directly or indirectly interested financially in the Contract.



## **ARTICLE 65. LAWS AND REGULATIONS**

- a. Contractor shall give all notices and comply with all federal, state, and local laws, ordinances, rules and regulations bearing on conduct of work as indicated and specified by their terms. References to specific laws, rules or regulations in the Contract Documents are for reference purposes only and shall not limit or effect the applicability of provisions not specifically mentioned. If Contractor observes that drawings and specifications are at variance therewith, he shall promptly notify the Engineer in writing and any necessary changes shall be adjusted as provided for in this Contract for changes in work. If Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without such notice to the Engineer, he shall bear all costs arising therefrom.
- b. Contractor shall be responsible for familiarity with the Americans with Disabilities Act ("ADA") (42 U.S.C. § 12101 et seq.). The Work will be performed in compliance with ADA laws, rules and regulations. Contractor shall comply with the Historic Building code, including but not limited to, as it related to the ADA, whenever applicable.
- c. Contractor acknowledges and understands that, pursuant to Public Contract Code section 20676, sellers of "mined material" must be on an approved list of sellers published pursuant to Public Resources Code section 2717(b) in order to supply mined material for this Contract.

## **ARTICLE 66. PATENT FEES OR ROYALTIES**

The Contractor shall include in its bid amount the patent fees or royalties on any patented article or process furnished or used in the Work. Contractor shall assume all liability and responsibility arising from the use of any patented, or allegedly patented, materials, equipment, devices or processes used in or incorporated with The Work, and shall defend, indemnify and hold harmless the City, its officials, officers, agents, employees and representatives from and against any and all liabilities, demands, claims, damages, losses, costs and expenses, of whatsoever kind or nature, arising from such use.

## **ARTICLE 67. OWNERSHIP OF DRAWING**

All Contract Documents furnished by the City are City property. They are not to be used by Contractor or any subcontractor on other work nor shall Contractor claim any right to such documents. With exception of one complete set of Contract Documents, all documents shall be returned to the City on request at completion of The Work.

## **ARTICLE 68. NOTICE OF TAXABLE POSSESSORY INTEREST**

In accordance with Revenue and Taxation Code Section 107.6, the Contract Documents may create a possessory interest subject to personal property taxation for which Contractor will be responsible.



## **ARTICLE 69. LAND AND RIGHT-OF-WAY**

The City will furnish and pay for the land, easement, and rights-of-way for the Work. For any area outside of the City site to be used by the Contractor, the Contractor shall coordinate with the property owner, obtain written permission from the property owner for use of the area, coordinate with any resource or permitting agency that may have jurisdiction over the area, obtain and pay for any permits or agreements and provide any environmental mitigation required, and pay any fees or rental charges required for use of the area. The Contractor shall be responsible for returning all areas used to their original conditions. At least 14 days prior to moving onto any site, the Contractor shall submit to the City Representative for approval a copy of the written permission letter from the property owner of that area, and description of any permits and mitigation actions that are required for use of the area.

Work in public right of way shall be done in accordance with the requirements of the permit issued by the public agency in whose right of way the work is located in addition to conforming to the plans and specifications. If a permit is not required, the work shall conform to the standards of the public agency involved in addition to conforming to the plans and specifications.



## **00750 - SPECIAL CONDITIONS**

### **1. FINDINGS REGARDING SPECIFIC MATERIALS, PRODUCTS, THINGS OR SERVICES FOR THE PROJECT.**

The City has made the following findings as they relate to need for the use of specific material(s), product(s), thing(s), and/or service(s) that must be utilized for the Project pursuant to the provisions of Public Contract Code section 3400:

#### **A. ChargePoint Electric Vehicle Chargers**

ChargePoint Electric Vehicle (EV) charge stations have been designated as a particular material product and service required for the contract.

The City has made findings that this product manufacturer and type has been required as particular product, material, thing or service to match other EV chargers in use on City of Santee owned facilities and connect to the existing ChargePoint service account with the City of Santee for their operation, maintenance and accounting purposes.

#### **B. Calsense Irrigation Controllers**

Calsense Irrigation controllers have been designated as a particular material product and service required for the contract.

The City has made findings that this product manufacturer and model type has been required as particular product, material, thing or service to match other Calsense irrigation controllers in use on City of Santee owned facilities and connect to the existing Calsense irrigation management system and account with the City of Santee for their operation and maintenance.

#### **C. Crestron Electronics**

Crestron Electronics have been designated as a particular material product and service required for the contract.

The City has made findings that this product manufacturer had been required as a particular product, material thing or service to match other audio visual controls used in City of Santee owned facilities and connect to the existing audio visual systems and account with the City of Santee for operations and maintenance.

#### **D. Fortinet**

Fortinet has been designated as a particular material product and service required for the contract.

The City has made findings that this product manufacturer has been



required as a particular product, material, thing or service to match other Fortinet systems in use by the City of Santee in order to maintain continuity of the City's security network.

## **2. MILESTONE SCHEDULING/PROJECT PHASING**

### **A. PHASE 1 - NEW YMCA PARKING LOT IMPROVEMENTS:**

The Contractor, as the first part of the construction activities shall complete the new parking lot directly north of the existing Cameron Family YMCA building to provide parking for the YMCA operations during the Construction of the Santee Community Center building and its associated site work. During this first stage of work, the Contractor shall not occupy or stage in the existing parking lot (east of main entrance drive isle from Riverwalk Drive). Contractor shall provide for temporary pedestrian access to the YMCA building and onsite pool equipment building for chemical deliveries, pool maintenance and landscape maintenance.

Limits of work for this phase shall be the western most improvements of the parking lot shown on the drawings and the access driveway (west of the main parking lot entrance from River Walk Drive to the YMCA from River Park Drive to the YMCA Building/Pool fencing perimeter. Parking lot items of work shall include all required grading, storm water pollution prevention, clearing and grubbing, earthwork, concrete curbs, gutters, sidewalks, pedestrian ramp, electrical, lighting, utilities, EV Chargers, aggregate base, asphalt concrete, striping, trash enclosure, landscape irrigation, landscape planting and BMP basins. Upon opening the Phase 1 improvements for use by the public, the City will take ownership of the improvements and be responsible for any damages as a result of the public use not related to defective work by the Contractor. Contractor is provided notice that the electric vehicle charge stations shown on the drawings to be installed in the Phase I improvement area have electrical service provided by the Community Center building panels and therefore will not be able to be energized until completion of Phase II improvements. Upon completion of the Phase II improvements and electrical service is provided to the Community Center building, the electric vehicle charge stations shall be installed and energized for the entire project (Phase I and Phase II areas). All required underground conduit and foundations for the Phase I electric vehicle charge stations shall be completed with Phase I.

The Phase I improvements shall be completed within **80 working days** from issuance of the notice to proceed.

### **B. PHASE 2 – COMMUNITY CENTER BUILDING, PARKING LOT AND SURROUNDING SITE IMPROVEMENTS:**

Upon completion of the Phase 1 Improvements, the Contractor will be



permitted to begin the Phase 2 improvements which includes the Community Center Building eastern parking lot and surrounding site improvements. The Contractor will be permit

The Phase II improvements shall be completed within **300 working days** from issuance of the notice to proceed for Phase II improvements the total 380 contract working days permitted in the contract.

### **3. CONSTRUCTION STAKING**

- A. The Contractor shall furnish construction staking and surveying as required to complete the project and described below and be responsible for all related cost for surveying and staking. Contractor shall give the City forty-eight (48) hours' notice in writing when he will require construction staking by the City. Contractor shall preserve all construction stakes, reference points, and other survey points. In case of their loss or destruction, the Contractor shall be liable for the cost of their replacement and of any expense resulting from their loss or disturbance. Do not proceed with the work that requires construction staking until construction stakes have been provided.
- B. Contractor shall carefully examine all construction stakes and shall confirm to their satisfaction that the line and grade information is in accordance with the approved plans. If there is an apparent error or lack of understanding as to what is meant by the staking, the Contractor shall request an interpretation from the Surveyor before proceeding with the work.
- C. The Work shall conform to the lines, grades, dimensions, tolerances, and material and equipment requirements shown on the plans or set forth in the specifications. Although measurement, sampling, and testing may be considered evidence as to such conformity, the Engineer shall be the sole judge as to whether the work or materials deviate from the plans and specifications, and their decision as to any allowable deviations therefrom shall be final.
- D. If the specific lines, grades, and dimensions are not shown on the approved plans, those furnished by the Engineer shall govern.
- E. Any additional construction stakes required for the replacement of existing improvements that were removed or disturbed at the Contractor's option shall be the Contractor's responsibility.

### **4. GEOTECHNICAL TESTING AND INSPECTION**

3<sup>rd</sup> party Geotechnical testing is required for the contract at the responsibility of the Contractor.



- A. The Contractor shall engage the services of a geotechnical engineering firm or individual licensed in the State of California to take samples and perform moisture content, gradation, compaction, and density tests during placement of backfill materials to check compliance with these specifications. In addition, compaction testing shall be performed for all asphalt concrete, aggregate base, subgrades for concrete curbs, gutters, sidewalks, walkways and retaining wall or stair footings. Sampling and testing procedures shall be performed in accordance with industry accepted Reference Standards.
- B. A building pad certification shall be provided by a licensed professional geotechnical or civil engineer certifying that the building pad was constructed and compacted to the soils report certification. Building Pad Certification shall be provided to the City prior to final construction of the building pad.
- C. The Contractor shall remove surface material at locations designated by the City and provide such assistance as necessary for sampling and testing. The City may direct the Contractor to construct inspection trenches in compacted or consolidated backfill to determine that the Contractor has complied with these specifications.
- D. Where compaction tests indicate a failure to meet the specified compaction, the Contractor shall re-work the entire area until the specified compaction has been achieved.
- E. The Contractor shall bear the costs for sampling and testing specified in this paragraph. The Contractor shall bear the costs associated with any re-testing or additional testing of work not conforming to the specifications or due to the Contractor's failure to comply with the specifications.
- F. Investigations and Reports - The following reports, which have been prepared for the City, are available for review on the City of Santee website [www.cityofsantee.ca.gov](http://www.cityofsantee.ca.gov) on the Bid Opportunities page under the Santee Community Center project. Copies of the reports can be made available upon request at Santee City Hall, Department of Engineering, 10601 Magnolia Avenue, Santee CA 92071.
  - 1. Geotechnical Report dated June 15, 2022 by Group Delta Consultants, Inc.
  - 2. Geotechnical Review of Foundation Plans, Grading Plans and Specifications dated June 15, 2022 by Group Delta Consultants
  - 3. Drainage Study dated February 2025 by Psomas



4. Preliminary Storm Water Pollution Prevention Plan dated January 2024 prepared by Psomas

The Preliminary Storm Water Pollution Prevention Plan is being provided for bidding purposes only and is not for construction. The Storm Water Pollution Prevention Plan will be revised and signed by Psomas upon submission of the Contractor's Construction Schedule to allow the Contractor to file the Notice of Intent.

5. Storm Water Quality Management Plan dated July 2025 prepared by Psomas
6. Initial Study / Mitigated Negative Declaration dated April 2025 prepared by Dudek

## 5. PERMITTING

The Contractor shall be responsible for all required permitting for the Contract as defined below:

- A. City of Santee - Grading Permits, Encroachment Permits and Building Permits

The City will be responsible for all required Grading Permits, Encroachments and Building Permits necessary for the work and shall be responsible for paying all associated costs for those permits.

Coordination for all building permit inspection shall be the responsibility of the Contractor. The Contractor shall request inspections for all required building permit inspections through the City's online permitting system at [www.santeeportal.org](http://www.santeeportal.org) a minimum of 24 hours prior to the requested date of inspection.

- B. City of Santee – Fire Alarm and Fire Sprinkler Permits (Deferred Submittal)

The Contractor shall be responsible for the preparation of all plans, reports, calculations and permit documents necessary for the building and installation of the Fire Alarm and Fire Sprinkler Permits. The Contractor shall ensure the Fire Alarm System connects and communicates with the Inergen Fire Suppression System located within the communication/server room. The Fire Alarm/Fire Suppression System and HVAC System shall be designed and installed to provide a global HVAC shut down in the event the Fire Alarm/Fire Sprinkler/Inergen Systems are activated.

The Contractor shall submit all permit documents to the City's online permitting system at [www.santeeportal.org](http://www.santeeportal.org) for review and approval prior to construction. Fire alarm and Fire Sprinkler permit documents shall be submitted prior to inspection requests for framing and structural members



to ensure the deferred design can be completed. The Contractor shall be responsible for all costs necessary to prepare the permit documents, submission to the City's online permitting system and the required plans, reports, calculations and inspection coordination. The City will be responsible for the permit costs and inspection fees.

C. City of Santee - Inergen Fire Suppression System (Deferred Submittal)

The Contractor shall be responsible for the preparation of all plans, reports, calculations and permit documents necessary for the building Inergen Fire Suppression System permits. The Contractor shall submit all permit documents to the City's online permitting system at [www.santeeportal.org](http://www.santeeportal.org) for review and approval prior to construction. The Inergen Fire Suppression System is only required for the communication/server room. The Contractor shall ensure that the Inergen Fire Suppression System connects with and communicates with the Fire Alarm System for the building. The Contractor shall be responsible for all costs necessary to prepare the permit documents, submission to the City's online permitting system and the required plans, reports, calculations and inspection coordination. The City will be responsible for the permit costs and inspection fees

D. City of Santee – Photo Voltaic System (Deferred Submittal)

The Contractor shall be responsible for the preparation of all plans, reports, calculations and permit documents necessary for the building Photovoltaic system as a deferred submittal. Photovoltaic system shall be designed in accordance with the California Green Energy Code and sized to provide at least 2.0 watts/SF of the building whichever is greater. The minimum generation of the PV panels shall be 400 Watt/panel. A 25-year solar generation performance warranty and a 10-year panel, inverter and installation warranty shall be provided by the Contractor. The contractor shall submit all permit documents to the City's online permitting system at [www.santeeportal.org](http://www.santeeportal.org) for review and approval prior to construction. PV permit documents shall be submitted prior to inspection requests for framing and structural members to ensure the deferred design can be completed. The Contractor shall be responsible for all costs necessary to prepare the permit documents, submission to the City's online permitting system and the required plans, reports, calculations and inspection coordination. The City will be responsible for the permit costs and inspection fees.

E. Storefront Systems (Deferred Submittal)

The Contractor shall be responsible for the preparation of all plans, reports, calculations and permit documents necessary for the building Storefront System permits. The Contractor shall submit all permit documents to the City's online permitting system at [www.santeeportal.org](http://www.santeeportal.org) for review and approval prior to construction. The Contractor shall be responsible for all



costs necessary to prepare the permit documents, submission to the City's online permitting system and the required plans, reports, calculations and inspection coordination. The City will be responsible for the permit costs and inspection fees.

F. Curtain Wall System (Deferred Submittal)

The Contractor shall be responsible for the preparation of all plans, reports, calculations and permit documents necessary for the building Curtain Wall System permits. The Contractor shall submit all permit documents to the City's online permitting system at [www.santeeportal.org](http://www.santeeportal.org) for review and approval prior to construction. The Contractor shall be responsible for all costs necessary to prepare the permit documents, submission to the City's online permitting system and the required plans, reports, calculations and inspection coordination. The City will be responsible for the permit costs and inspection fees.

G. Elevator Guardrails (Deferred Submittal)

The Contractor shall be responsible for the preparation of all plans, reports, calculations and permit documents necessary for the building Elevator Guardrail permits. The Contractor shall submit all permit documents to the City's online permitting system at [www.santeeportal.org](http://www.santeeportal.org) for review and approval prior to construction. The Elevator Guardrail permit documents shall be submitted prior to inspection requests for framing and structural members to ensure the deferred design can be completed. The Contractor shall be responsible for all costs necessary to prepare the permit documents, submission to the City's online permitting system and the required plans, reports, calculations and inspection coordination. The City will be responsible for the permit costs and inspection fees.

H. Electric Vehicle Charging Stations (Deferred Submittal)

The Contractor shall be responsible for the preparation of all plans, reports, calculations and permit documents necessary for the building Electric Vehicle Charging Stations permits. The Contractor shall submit all permit documents to the City's online permitting system at [www.santeeportal.org](http://www.santeeportal.org) for review and approval prior to construction. The Electric Vehicle Charging Stations permit documents shall be submitted and approved prior to construction.

Electric Vehicle Charge Stations shall be as manufactured by ChargePoint Model CT-4021-GW1-CR for all shown dual station chargers and shall be Model CT-4011-GW1-CR for all shown single station chargers and connect to the City of Santee's existing service account with ChargePoint. Sole source determination has been provided in the Special Conditions. Each charge station shall include the manufacturers five (5) year warranty



“Assure Warranty” and the commercial cloud communication plan for a period of five (5) years (CPCLD-Commercial Cloud Plan). For dual station chargers this will require two (2) plans per station and the Contractor shall contact ChargePoint to insure the stations provided include all required items to be fully functional and warranted for a period of five (5) years.

The Contractor shall be responsible for all costs necessary to prepare the permit documents, submission to the City’s online permitting system and the required plans, reports, calculations and inspection coordination. The City will be responsible for the permit costs and inspection fees

I. Nanawall Sliding Doors (Deferred Submittal)

The Contractor shall be responsible for the preparation of all plans, reports, calculations and permit documents necessary for the building Nanawall Sliding Door permits. The Contractor shall submit all permit documents to the City’s online permitting system at [www.santeeportal.org](http://www.santeeportal.org) for review and approval prior to construction. The Contractor shall be responsible for all costs necessary to prepare the permit documents, submission to the City’s online permitting system and the required plans, reports, calculations and inspection coordination. The City will be responsible for the permit costs and inspection fees

J. Commissioning Plan (Deferred Submittal)

The Contractor shall be responsible for the preparation of all plans, reports, calculations and documents necessary for the building Commissioning Plan. The Contractor shall submit all documentation to the City’s online permitting system at [www.santeeportal.org](http://www.santeeportal.org) for review and approval prior to construction. The Commissioning Plan documents shall be submitted and approved within sixty (60) days of the issuance of the Notice to Proceed (NTP). The Commissioning Plan shall comply with all requirements of a Tier 2 Project under the California Green Code.

The Contractor shall be responsible for all costs necessary to prepare the plan, submission to the City’s online permitting system and the required, reports, calculations and inspection coordination. The City will be responsible for all costs and inspection fees.

The City has procured a price quotation from MBO Inc. for the preparation and inspection related to the Commissioning Plan, Attachment G The Contractor may execute a contract MBO Inc. for the Commissioning Plan or may submit a Commissioning Plan compliant with the California Green Code prepared by a separate Firm.

K. County of San Diego Department of Environmental Health Permits



The Contract includes the installation of a diesel-powered backup emergency generator with integrated above ground diesel tank. The Contractor shall be responsible for obtaining all necessary permits and inspections on behalf of the City required for the generator installation as required by the County of San Diego Department of Environmental Health (DEH). The preparation of a site specific Hazardous Materials Business plan for the installation, operation and maintenance of the emergency generator shall be completed by the Contractor for the City's review and approval prior to submission to the County of San Diego. The Contractor shall be responsible for all costs associated with preparing the necessary permit documents, permit fees, inspection fees, hazardous materials business plan and inspections necessary for a fully operational emergency generator.

L. San Diego County Air Pollution Control District Permits

The Contract includes the installation of a diesel-powered backup emergency generator with integrated above ground diesel tank. The Contractor shall be responsible for obtaining all necessary permits and inspections on behalf of the City required for the generator installation, the operation and maintenance plans and all items as required by the San Diego County Air Pollution Control District for Permit approval. The Contractor shall be responsible for all costs associated with preparing the necessary permit documents, permit fees, inspection fees, and inspections necessary for a fully operational emergency generator.

## **6. AIR QUALITY MONITORING AND MITIGATION MEASURES**

During construction, standard construction practices shall be employed to reduce fugitive dust emissions and include watering of the active sites and exposed surfaces up to two times per day, depending on weather conditions; watering unpaved roads; and limiting vehicle speeds on unpaved roads. Construction of the project would be subject to SDAPCD Rule 55 – Fugitive Dust Control. Compliance with Rule 55 would limit fugitive dust that may be generated during grading and construction activities.

**Tier 4 Final Construction Equipment.** Prior to the commencement of construction activities for the project, the Contractor shall demonstrate that all 75-horsepower or greater diesel-powered equipment is powered with California Air Resources Board-certified Tier 4 Final engines.

An exemption from these requirements may be granted if the Contractor documents that equipment with the required tier is not reasonably available and that equivalent reductions in PM<sub>10</sub> exhaust emissions are achieved from other combinations of construction equipment. Before an exemption may be considered the Contractor shall demonstrate that three construction fleet owners/operators in the San Diego region were contacted and that those owners/operators confirmed



Tier 4 equipment could not be located within the San Diego region. The City shall review the exemption request and provide a determination within 10 business days from receipt of the request

## **7. BIOLOGICAL RESOURCES, MONITORING AND MITIGATION MEASURES**

### **PRIOR TO THE START OF CONSTRUCTION:**

A qualified Project biologist approved by the City of Santee shall monitor ground-disturbing and vegetation-clearing activities for the duration of the Project to ensure that practicable measures are being employed to avoid incidental disturbance of habitat, species of concern, and other sensitive biological resources outside the Project footprint. Once ground-disturbing and vegetation-clearing activities are complete, the Project biologist shall conduct weekly checks to inspect construction fencing and ensure that all applicable requirements from the mitigation measures are being upheld.

Before beginning activities that would cause impacts, the Contractor shall, in consultation with the biological monitor, clearly delineate the boundaries with fencing, stakes, or flags, consistent with the grading plan, within which the impacts will take place. All impacts outside the fenced, staked, or flagged areas shall be avoided, and all fencing, stakes, and flags shall be maintained until the completion of impacts in that area. In addition, any avoided environmental resources shall be clearly delineated. Prior to implementing construction activities, the biological monitor shall verify that the flagging clearly delineates the construction limits and any sensitive environmental resources to be avoided.

A pre-construction meeting shall be required that includes a training session for Project personnel by a qualified biologist. The training shall include:

- (1) a description of the species of concern and its habitats;
- (2) the general provisions of the applicable regulations pertaining to biological resources, including the Endangered Species Act and the Clean Water Act;
- (3) the need to adhere to the provisions of the Endangered Species Act, the Clean Water Act, and other applicable regulations;
- (4) the penalties associated with violating the provisions of the Endangered Species Act, Clean Water Act, and other applicable regulations;
- (5) the general measures that are being implemented to conserve the species of concern as they relate to the Project; and
- (6) the access routes to and Project site boundaries within which the Project activities must be accomplished. Additionally, the training shall include the measures and mitigation requirements for the applicable resources. Copies



of the mitigation measures and any required permits from the resource agencies shall be made available to construction personnel.

Prior to the start of ground-disturbing activities within all potential nesting resource areas within the Project site (i.e., ornamental trees) and areas of the Project site within 500 feet of the Woodglen Vista Creek should be avoided during the migratory bird nesting season (typically January 1 through September 30). If construction activities (i.e., grading, tree removal, external construction involving heavy equipment generating noise in excess of 60 A-weighted decibels [dBA] (leq)) must occur during the bird nesting season, an avian nesting survey of all potential nesting resource areas (e.g., ornamental trees) within the Project site and areas of the Woodglen Vista Creek within 500 feet of all impact areas must be conducted to determine the presence/absence of special-status species, protected migratory birds, and active nests. If least Bell's vireo (*Vireo bellii pusillus*) is identified during the surveys, then noise attenuation measures shall be required to ensure that noise levels from construction do not exceed a 60 dBA hourly average per hour at the edge of the riparian habitat or to the ambient noise level if it exceeds 60 dBA prior to construction. Construction noise monitoring shall be required to verify that noise levels at the edge of occupied habitat are maintained below 60 dBA hourly average unless an analysis completed by a qualified acoustician shows that noise generated by construction activities would not exceed 60 dBA hourly average at the edge of occupied habitat.

The avian nesting survey shall be performed by a qualified wildlife biologist within 14 days prior to the start of construction and one more survey pass within 24 hours of initiation of construction activities in accordance with the Migratory Bird Treaty Act and California Fish and Game Code Sections 3503, 3503.5, and 3513. If construction activities are on hold for more than 30 days, then pre-construction surveys would need to be reinitiated. If an active bird nest is found, the nest shall be flagged and mapped on the construction plans, along with an appropriate buffer established around the nest, which will be determined by the biologist based on the species' sensitivity to disturbance (typically 300 feet for passerines and 500 feet for raptors and special-status species), existing nearby conditions (e.g., natural habitat versus roads or existing noisy activities), existing buffering features (e.g., topography, tall and dense trees, buildings), legal status of species (i.e., listed versus non-listed), general sensitivities of the species (e.g., disturbance tolerant or urban versus non disturbance tolerant), and other variables. The nest area shall be avoided until the nest is vacated and the juveniles have fledged. The nest area shall be demarcated in the field with flagging and stakes or construction fencing. On-site construction monitoring shall also be conducted when an active nest buffer is in place. No Project activities shall encroach into established buffers without the consent of a monitoring biologist. The buffer shall remain in place until it is determined that the nestlings have fledged and the nest is no longer active.

**DURING CONSTRUCTION:** The following measures shall be implemented to ensure that wildlife do not become trapped, entangled, injured, or poisoned by construction activities:



- Structures in which wildlife may become trapped (e.g., open pipes, pits, trenches) shall be tightly covered at the end of each work day. If covering the structure is not possible, an escape ramp shall be provided to allow any wildlife that falls in to safely escape.
- Debris piles, construction materials, equipment, and other items that may be used as wildlife refuge shall be inspected for wildlife at the start of each work day and prior to disturbance. If wildlife is discovered, it shall either be moved out of harm's way by a qualified biologist or allowed to move off of the Project site on its own.
- Nets and mesh shall be made of loose weave material that is not fused at the intersections of the weave because nets with welded weaves present an entanglement risk.
- Toxic materials and garbage shall be removed from the work site and safely stored or disposed of at the end of each work day.

All construction activities shall be conducted during the daytime, and lights shall not be kept on overnight in the construction area, as practicable. If night lighting is required during construction activities, all exterior lighting along undeveloped land shall be fully shielded and directed downward in a manner that will prevent light spillage or glare into the adjacent open space.

## **8. ARCHAEOLOGICAL MONITORING AND REPORTING**

**ROUGH GRADING:** Prior to any grading or site preparation activities the Contractor shall complete the following to the satisfaction of the applicable Department.

Prior to the start of ground-disturbing activities, the Contractor shall retain a qualified archaeologist who meets the Secretary of the Interior's Professional Qualifications Standards for archaeology (U.S. Department of the Interior 2012). The Contractor shall also retain a Native American monitor of Kumeyaay descent. (Planning)

Prior to the start of ground-disturbing activities, the qualified archaeologist shall conduct cultural resources sensitivity training for all construction personnel. Construction personnel shall be informed of the types of archaeological resources that may be encountered, and of the proper procedures to be enacted in the event of an inadvertent discovery of archaeological resources or human remains. The Contractor shall ensure that construction personnel attend the training and sign an attendance acknowledgement form. The Contractor shall provide copies of documentation demonstrating attendance to the City and retain documentation demonstrating attendance. (Planning)

**DURING GRADING:** During any grading, site preparation or construction activities,



the Contractor shall complete the following conditions to the satisfaction of the applicable Department:

The qualified archaeologist, or an archaeological monitor (working under the direct supervision of the qualified archaeologist), shall observe all initial ground-disturbing activities, including but not limited to brush clearance, vegetation removal, grubbing, grading, and excavation. The qualified archaeologist, in coordination with the City, may reduce or discontinue monitoring if it is determined by the qualified archaeologist that the possibility of encountering buried archaeological deposits is low based on observations of soil stratigraphy or other factors. Archaeological monitoring shall be conducted by an archaeologist familiar with the types of archaeological resources that could be encountered within the project site. The archaeological monitor shall be empowered to halt or redirect ground-disturbing activities away from the vicinity of a discovery until the qualified archaeologist has evaluated the discovery and determined appropriate treatment (as prescribed below). The archaeological monitor shall keep daily logs detailing the types of activities and soils observed, and any discoveries. After monitoring has been completed, the qualified archaeologist shall prepare a monitoring report that details the results of monitoring. The report shall be submitted to the City and any Native American groups who request a copy. A copy of the final report shall be filed at the South Coastal Information Center. (Planning)

## **9. NATIVE AMERICAN MONITOR**

A Native American Monitor of Kumeyaay descent shall be present for any pre-construction meeting and for all ground disturbing activities associated with the project. Should any cultural or tribal cultural resources be discovered, no further grading shall occur in the area of the discovery until the City Planner, or designee, with concurrence from the Native American Monitor, are satisfied that treatment of the resource has occurred. In the event that a unique archaeological resource or tribal cultural resource is discovered, and in accordance with Public Resources Code Section 21083.2(b)(1), (2), and (4), the resource shall be moved and buried in an open space area of the Project site, such as slope areas, which will not be subject to further grading activity, erosion, flooding, or any other ground disturbance that has the potential to expose the resource. The on-site area to which the resource is moved shall be protected in perpetuity as permanent open space. No identification of the resource shall be made on-site; however, the Contractor shall plot the new location of the resource on a map showing latitudinal and longitudinal coordinates and provide that map to the City and the Native American Heritage Commission (NAHC) for inclusion in the Sacred Lands File (SLF). Disposition of the resources shall be at the discretion of the City of Santee, but in accordance with the foregoing.

In the event of the unanticipated discovery of archaeological materials, all work shall immediately cease in the area (within 100 feet) of the discovery until it can be evaluated by the qualified archaeologist in consultation with the Native American monitor. Construction shall not resume until the qualified archaeologist has



conferred with the City on the significance of the resource.

If it is determined that the discovered archaeological resource constitutes a historical resource or a unique archaeological resource, avoidance and preservation in place is preferred. Preservation in place may be accomplished by, but is not limited to, avoidance, incorporating the resource into open space, capping, or deeding the site into a permanent conservation easement. In the event that preservation in place is demonstrated to be infeasible and data recovery through excavation is the only feasible option available, a Cultural Resources Treatment Plan shall be prepared and implemented by the qualified archaeologist in consultation with the City that provides for the adequate recovery of the scientifically consequential information contained in the archaeological resource. The qualified archaeologist and the City shall consult with appropriate Native American representatives in determining treatment for prehistoric or Native American resources to ensure cultural values ascribed to the resources, beyond those which are scientifically important, are considered.

If human remains are encountered, all work shall halt in the vicinity (within 100 feet) of the discovery and the San Diego County Coroner will be contacted in accordance with Public Resources Code (PRC) Section 5097.98 and Health and Safety Code Section 7050.5. The City shall also be notified. If the County Coroner determines that the remains are Native American, the NAHC will be notified in accordance with Health and Safety Code Section 7050.5, subdivision (c), and PRC Section 5097.98 (as amended by Assembly Bill 2641). The NAHC will designate a Most Likely Descendant (MLD) for the remains per PRC Section 5097.98. The MLD shall complete the inspection of the site within 48 hours of being granted access and shall provide recommendations for the treatment of the remains. Until the landowner has conferred with the MLD, the Contactor will ensure that the immediate vicinity where the discovery occurred is not disturbed by further activity, is adequately protected according to generally accepted cultural or archaeological standards or practices.

## **10. ENVIRONMENTAL SOUND MITIGATION MEASURES**

A 12' tall temporary construction noise barrier shall be installed and maintained by the Contractor during the construction of the Community Center building and all related work in accordance to the projects Mitigated Negative Declaration. The site boundary fencing shall be in the form of sound blankets or comparable temporary solid barrier to occlude construction noise emissions between the site and the noise-sensitive receptors of concern as outlined in the projects Mitigated Negative Declaration. The noise barrier shall be installed along the Woodglen Vista Creek Channel adjacent to the existing lodge pole fencing starting 250' north of the Community Center building structure south westerly and parallel to the creek around the Community Center building to the southeastern corner of the project site behind the Cameron Family YMCA where the projects sewer line and manhole improvements terminate, as depicted on Figure 11C of the projects Mitigated Negative Declaration. Contractor shall provide all required fencing, plywood,



sound blankets, maintenance of fencing and removal of the fencing at the completion of all work and pay for all associated costs with the work.

## **11. GEOLOGY & SOILS MITIGATION MEASURES**

A qualified paleontologist shall conduct a WEAT (worker environmental awareness training) for the construction crew members informing them of the potential to inadvertently encounter paleontological resources and the proper procedures to be enacted in the event of an inadvertent discovery. A qualified project paleontologist is a person with a doctorate or master's degree in paleontology or related field and who has knowledge of the County of San Diego paleontology and documented experience in professional paleontological procedures and techniques. The Contractor shall ensure that construction personnel attend the training and sign an attendance acknowledgement form. The applicant shall retain documentation demonstrating attendance. The qualified paleontologist shall observe all initial ground disturbing activities including grading and excavation. The qualified paleontologist, in coordination with the Contractor and the City, may reduce or discontinue monitoring if it is determined by the qualified paleontologist that the possibility of encountering buried paleontological resources is low based on observations of soil stratigraphy or other factors. In the unlikely event that paleontological resources (i.e., fossils) are exposed during construction activities, all construction work occurring within 50 feet of the find shall immediately stop and the lead agency representative contacted. The qualified vertebrate paleontologist meeting the Society of Vertebrate Paleontology standards, shall be assigned to review the unanticipated find to determine the significance. If the discovery proves potentially significant under CEQA as determined by the qualified vertebrate paleontologist, and the area cannot be feasibly avoided, additional work, such as preparation of a Paleontological Resources Impact Mitigation Program and paleontological monitoring shall be warranted.

## **12. PROJECT IDENTIFICATION SIGNS**

- A. YMCA Parking Lot Signage Two project identification signs shall be installed by the Contractor and used to provide information regarding the purpose of the construction, responsible agency (including logo), project contact information, cost and schedule. Contractor shall erect the signs prior to start of construction. The City will convey a time for the sign to be erected to inform the public prior to start of construction.
- B. Community Center Building Signs. Two project identification signs shall be installed by the Contractor and used to provide information regarding the purpose of the construction, responsible agency (including logo), building elevation schematic, and project contact information, cost and schedule. Contractor shall erect the signs prior to start of construction. The City will convey a time for the sign to be erected to inform the public prior to start of construction.



- C. The project identification sign shall consist of a base, framework and (4' x 8') sign panel. Signs shall be white with black lettering, All parts of the sign framework shall be furnished to match the color of the sign panel background.
  - 1. Project identification signs shall be placed as directed by the Engineer.
  - 2. The signs shall be kept clean and in good condition by the Contractor for the entire duration of the project. Contractor is responsible for all costs to repair any sign deemed in not proper working condition by the City.
  - 3. Project identification signs shall be removed and disposed of by the Contractor City at completion of the project.
- D. The Contractor shall be responsible for all costs associated with the fabrication, construction, erection, maintenance and removal of the projects signs.

### **13. ROCK REMOVAL**

Contractor is advised that rock may be present requiring removal by mechanical or chemical expansion methods. Blasting or use of explosives is strictly prohibited. The City has made no comprehensive investigation and has made no representations regarding the location, nature, or extent of any such rock. Contractor shall take this into account in making its bid, and Contractor agrees that no change order will be requested by Contractor and no extra payment will be made by the City for any costs incurred by Contractor by reason of any unforeseen rock or similar material, except as provided as follows:

- A. Rock encountered within the trench which cannot be removed using a caterpillar D-9L dozer, Caterpillar 330 excavator, or equivalent, in proper operating condition mounted with a single ripper tooth or 10,000 ft/lb impact energy pound breaker.
- B. After the Contractor has, in the opinion of the City, made a reasonable attempt to remove the rock using equipment equivalent to that described herein.

Additionally,

- C. Authorized rock removal will be considered a changed condition and paid for by the City as Extra Work in accordance with Article 45 of the General Conditions, and the specific requirements of this section. Payment for rock removal as Extra Work shall be payment in full for all work associated therewith and indicated thereto.



- D. The limits of rock removal for payment as Extra work shall be agreed upon in writing by the Contractor and the City prior to commencing rock removal operations.

The Contractor will not receive any additional payment for rock removal performed for the Contractor's convenience.

#### **14. GROUNDWATER POTENTIAL**

The project site lies adjacent to the Woodglen Vista Creek Channel which conveys drainage waters to the San Diego River. The Contractor is provided notice that ground water may be encountered during trenching, excavations, grading and foundation work related for the project. In addition the project site is located on the lower end of the project parcel in which subsurface moisture may be found during and after rain events due to the natural drainage of the site towards the Woodglen Vista Creek. The Contractor shall be responsible for all required dewatering work including the removal and legal disposal of groundwater if encountered during the work as required to complete all items of work.

#### **15. ACCESS OF CITY'S REPRESENTATIVE'S PERSONNEL TO CONFINED SPACES IN STRUCTURES UNDER CONSTRUCTION**

- A. The Contractor shall be aware that some or all portions of the work may be designated as a PERMIT REQUIRED CONFINED SPACE. The Contractor is required to provide the City with a copy of the Contractor's Confined Space Program for Owner's review and acceptance prior to beginning work. Contractor's Confined Space Program shall be in compliance with Cal-OSHA's Confined Space regulatory requirements. The Contractor is required to perform all work in accordance with Cal-OSHA Confined Space requirements.
- B. The Contractor shall provide the following assistance to the personnel of the City's Representative when said personnel must enter confined spaces in structures under construction or structures which have not been accepted by the City.
  - 1. Training program for the City's Representative's personnel relevant to the specific structures being entered.
  - 2. Testing equipment and personnel to operate said equipment for testing the atmosphere in the confined spaces for oxygen deficiency, explosive gases, and toxic gases.
  - 3. Authorized competent person to stand by each confined space while entrants are inside the space.
  - 4. Safety equipment (breathing apparatus, harnesses, and rescue equipment) in good working order.



5. Communication equipment.
  6. Access equipment (hoists and ladders).
  7. Signs.
  8. Alarm system.
  9. Ventilation system.
- C. The Contractor shall identify confined spaces on the project, mark them with warning signs per OSHA requirements, and notify the City's Representative that these structures now exist.

## 16. COVID-19 SAFETY MEASURES

- A. Contractors shall comply with all applicable current and future federal, state, and local laws, regulations, statutes, ordinances, and orders. This includes, but is not limited to, applicable portions of the County of San Diego Health Officer's order that became effective on June 8, 2020, and any future updates thereto.

(<https://www.sandiegocounty.gov/content/dam/sdc/hhsa/programs/phs/Epi/demiology/HealthOfficerOrderCOVID19.pdf>.)

- B. Contractor shall implement, and require its subcontractors to implement, measures to protect employees, visitors, and anyone else related to the Project from COVID-19 and other infectious diseases. These measures shall include, but not be limited to, the following: update its Injury and Illness Prevention Plan, generate a worksite-specific COVID-19 prevention plan, designate a person at each worksite to implement the plans, provide training on preventing the spread of diseases, increase availability of handwashing stations, routinely disinfect common areas, enforce physical distancing, require cloth face coverings, encourage workers who are sick to stay at home, provide alcohol based wipes to clean tools before and after use, avoid carpooling, implement health screening programs to ensure that employees showing up to work are healthy, and immediately send employees with acute respiratory illness symptoms home or to medical care as needed. In its implementation of COVID-19-related safety measures, Contractor shall be aware of and take into account the following guidance:

1. California Department of Public Health, *COVID-19 Industry Guidance: Construction*, <https://covid19.ca.gov/pdf/guidance-construction.pdf>
2. Cal/OSHA, *Interim General Guidelines on Protecting Workers from COVID-19*, <https://www.dir.ca.gov/dosh/coronavirus/General-Industry.html>



3. Cal/OSHA, *COVID-19 Infection Prevention in Construction*, <https://www.dir.ca.gov/dosh/coronavirus/COVID-19-Infection-Prevention-in-Construction.pdf>
4. OSHA, *Guidance on Preparing Workplaces for COVID-19* (OSHA 3990-03), <https://www.osha.gov/Publications/OSHA3990.pdf>
5. OSHA, *COVID-19 Guidance for the Construction Workforce* (OSHA 4000-04), <https://www.osha.gov/Publications/OSHA4000.pdf>
6. OSHA, *COVID-19 - Control and Prevention / Construction Work*, <https://www.osha.gov/SLTC/covid-19/construction.html>

## **17. UTILITY SERVICES AND SERVICE ORDERS**

### **A. SDG&E**

The service order has been obtained from SDG&E during the design phase of the project and is attached as Attachment H. The Contractor is responsible for scheduling and coordinating all related SDG&E services related to the project. The Contractor is responsible for paying all fees relating to the installation and inspection of the service for the service order. The Contractor is responsible for restoring all asphalt concrete on Riverwalk Drive and the existing parking lot pursuant to the City of Santee Trench Resurfacing Detail PW-01. The Contractor is responsible for restoring all curbs, gutters and sidewalks joint to joint per applicable San Diego County Regional Standard Drawings G-2 and G-7. All colored concrete and exposed aggregate sidewalk shall be matched to existing. The Contractor is responsible for restoring all existing landscape and irrigation along Riverwalk Drive and within the existing parking lot. Inspections shall be scheduled two (2) weeks in advance of the required inspection.

### **B. Padre Dam Municipal Water District**

The Contractor shall coordinate and schedule all required inspection for water, sewer and recycled water through the Padre Dam Municipal Water District. The City will pay all capacity fees, service order fees and inspection fees. Inspections shall be scheduled two (2) weeks in advance of the required inspection.

### **C. County of San Diego Department of Environmental Health and Quality**

#### **a. Recycled Water Irrigation Inspection and Cross Connection Testing**

The Contractor shall coordinate and schedule the recycled water irrigation inspection and cross connection testing required for the recycled water irrigation system with the County of San Diego Department of Environmental Health. The City will pay for all permit and inspection fees required for the recycled water inspection and cross connection testing. This



inspection will require coordination with the Padre Dam Municipal Water District. Inspections shall be scheduled two (2) weeks in advance of the required inspection.

b. Food and Housing Division

The Contractor shall coordinate and schedule the Food and Housing Division inspection necessary for the Kitchen equipment and operations with the County of San Diego Department of Environmental Health. Prior to scheduling the required inspections all kitchen work and food service equipment shall be completed with power, water, sewer and hot water provided for the inspection. The kitchen shall be fully cleaned and free of all dirt, dust, grease, oils or other foreign materials. The City will pay for all permit and inspection fees associated with the Food and Housing Division. Inspections shall be scheduled two (2) weeks in advance of the required inspection.

D. Cox Communications

The Contractor shall coordinate the Cox Communications service order installation and inspection required to provide phone, internet and data service to the building. The City will pay all service order fees and installation required for the project. Inspections shall be scheduled two (2) weeks in advance of the required inspection.

E. City of Santee Fiber Optic Service and Cables

The project requires fiber optic communication service from the City's existing fiber communications system located at the intersection of Mast Boulevard and Park Center Drive to be run to the project site along Park Center Drive and Riverwalk Drive through an existing 2" conduit installed for the project. This conduit run is not shown on the project drawings. The Contractor shall install conduit from the existing pull box on Riverwalk Drive at the project's property line into the building as shown on the Technology drawings. The fiber optic cable shall be a Corning Los Altos Gel Free 12 strand fiber optic cable, or approved equal. The fiber optic cable shall be installed from the splice box at southeast corner of Park Center Drive at Mast Blvd through the existing pull box on the southwest corner of Park Center Drive at Mast Blvd through the pull box in front of the Community Center building and into the Community Center building data communication room, approximately 2,100 feet. The Contractor shall coil 20 additional feet of fiber optic cable in each pull box and 50 feet at all splice locations for a total anticipated fiber optic cable length of 2,400 feet.

The Contractor is responsible for splicing new fiber optic cable in the existing splice cannister at Park Center Drive and Mast Blvd. The Contractor shall furnish and install a 1U Corning splice enclosure with LC splice cassettes inside the communications room of the Community Center and make all necessary



splice connections to connect all twelve (12) fibers. The Contractor shall be responsible for all required patch cables to connect the City's network. The Contractor shall provide documentation of ODTR Testing of the fiber optic cable to the City for review prior to acceptance of the work.

The Contractor is responsible for restoring all asphalt concrete on Riverwalk Drive and the existing parking lot pursuant to the City of Santee Trench Resurfacing Detail PW-01. The Contractor is responsible for restoring all curbs, gutters and sidewalks joint to joint per applicable San Diego County Regional Standard Drawings G-2 and G-7. All colored concrete and exposed aggregate sidewalk shall be matched to existing. The Contractor is responsible for restoring all existing landscape and irrigation along Riverwalk Drive and within the existing parking lot.

**18. FIXTURES FURNISHING AND EQUIPMENT (FF&E)**

The Contractor shall furnish and install all fixtures, furnishing and equipment (FF&E) as shown on the FF&E list attached as Attachment X. The Contractor is responsible for all labor, materials, tools, shipping, installation and locating as directed by the City Project Manager or Inspector of all FF&E on the attached FF&E list. The Contractor shall provide all standard warranties, operation and maintenance manuals, and installation manuals for all FF&E's 30 days prior to the project completion. All FF&E's must be furnished and installed 30 days prior to project completion.



**100% CONSTRUCTION DOCUMENTS**

**CIP 2018 - 31**

**SANTEE COMMUNITY CENTER**

10129 Riverwalk Dr., Santee, CA 92071

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2290003000

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City of Santee

10601 Magnolia Ave., Santee, CA 92071



July 11, 2025

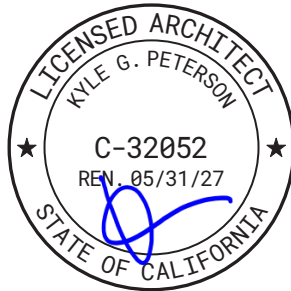
HMC Architects



**SANTEE COMMUNITY CENTER**  
**City of Santee**  
**Santee, California**

**CIP 2018 - 31**

July 11, 2025  
HMC #2290003000



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HMC ARCHITECTS  
Architect



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Saiful Bouquet Inc.



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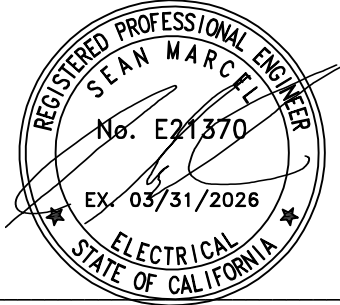
Syska Hennessy Group  
Mechanical/Plumbing Engineers



**SANTEE COMMUNITY CENTER**  
**City of Santee**  
**Santee, California**

**CIP 2018 - 31**

March 31, 2025  
HMC #2290003000



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Syska Hennessy Group  
Electrical Engineer



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Psomas  
Civil Engineer



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MIG  
Landscape Architect



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12 36 00 - COUNTERTOPS  
12 48 13 - ENTRANCE FLOOR MATS AND FRAMES

DIVISION 13 - SPECIAL CONSTRUCTION

NOT APPLICABLE



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DIVISION 14 - CONVEYING EQUIPMENT

NOT APPLICABLE

DIVISION 21 - FIRE SUPPRESSION

NOT APPLICABLE

DIVISION 22 - PLUMBING

22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT  
22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING  
22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING  
22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING  
22 05 19 - METERS AND GAGES FOR PLUMBING PIPING  
22 05 23.12 - BALL VALVES FOR PLUMBING PIPING  
22 05 23.13 - BUTTERFLY VALVES FOR PLUMBING PIPING  
22 05 23.14 - CHECK VALVES FOR PLUMBING PIPING  
22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT  
22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT  
22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT  
22 05 93 - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING  
22 07 19 - PLUMBING PIPING INSULATION  
22 11 16 - DOMESTIC WATER PIPING  
22 11 19 - DOMESTIC WATER PIPING SPECIALTIES  
22 11 23.21 - INLINE, DOMESTIC-WATER PUMPS  
22 13 16 - SANITARY WASTE AND VENT PIPING  
22 13 19 - SANITARY WASTE PIPING SPECIALTIES  
22 13 19.13 - SANITARY DRAINS  
22 14 13 - FACILITY STORM DRAINAGE PIPING  
22 14 23 - STORM DRAINAGE PIPING SPECIALTIES  
22 33 00 - ELECTRIC, DOMESTIC-WATER HEATERS  
22 42 13.13 - COMMERCIAL WATER CLOSETS  
22 42 13.16 - COMMERCIAL URINALS  
22 42 16.13 - COMMERCIAL LAVATORIES  
22 42 16.16 - COMMERCIAL SINKS  
22 47 16 - PRESSURE WATER COOLERS

DIVISION 23 - HEATING, VENTILATING, AND AIR-CONDITIONING(HVAC)

23 05 00.1 - COMMON WORK RESULTS FOR HVAC  
23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC  
23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT  
23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC  
23 07 13 - DUCT INSULATION  
23 09 23.12 - CONTROL DAMPERS  
23 09 23.14 - FLOW INSTRUMENTS  
23 09 23.22 - POSITION INSTRUMENTS  
23 09 23.23 - PRESSURE INSTRUMENTS

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23 09 23.27 - TEMPERATURE INSTRUMENTS  
23 23 00 - REFRIGERANT PIPING  
23 31 13 - METAL DUCTS  
23 33 00 - AIR DUCT ACCESSORIES  
23 33 46 - FLEXIBLE DUCTS  
23 34 23 - HVAC POWER VENTILATORS  
23 36 00 - AIR TERMINAL UNITS  
23 37 13.13 - AIR DIFFUSERS  
23 37 13.23 - REGISTERS AND GRILLES  
23 72 19 - FIXED PLATE AIR-TO-AIR ENERGY RECOVERY UNITS  
23 74 16.13 - PACKAGED ROOFTOP AIR-CONDITIONING UNITS  
23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS  
23 81 29 - VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

## DIVISION 25 - INTEGRATED AUTOMATION

NOT APPLICABLE

## DIVISION 26 - ELECTRICAL

26 05 00.1 - COMMON WORK RESULTS FOR ELECTRICAL  
26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES  
26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS  
26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS  
26 05 36 - CABLE TRAYS FOR ELECTRICAL SYSTEMS  
26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS  
26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING  
26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS  
26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS  
26 05 73.13 - SHORT-CIRCUIT STUDIES  
26 05 73.16 - COORDINATION STUDIES  
26 05 73.19 - ARC-FLASH HAZARD ANALYSIS  
26 22 13 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS  
26 24 13 - SWITCHBOARDS  
26 24 16 - PANELBOARDS  
26 27 26 - WIRING DEVICES  
26 28 13 - FUSES  
26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS  
26 29 13.03 - MANUAL AND MAGNETIC MOTOR CONTROLLERS  
26 32 13 - ENGINE GENERATORS  
26 36 00 - AUTOMATIC TRANSFER SWITCH  
26 36 00 - TRANSFER SWITCHES  
26 51 13 - LIGHTING

## DIVISION 27 - COMMUNICATIONS

27 00 00 - COMMUNICATIONS  
27 05 10 - COMMUNICATIONS SYSTEMS FIRESTOPPING  
27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEM  
27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

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27 05 29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS  
27 05 43 - UNDERGROUND CONDUITS AND DUCT BANKS  
27 05 53 - IDENTIFICATION FOR COMMUNICATION SYSTEMS  
27 11 16 - COMMUNICATIONS RACKS, CABINETS AND ENCLOSURES  
27 11 19 - COMMUNICATIONS TERMINATION BLOCKS & PATCH PANELS  
27 11 23 - COMMUNICATIONS CABLE MANAGEMENT & LADDER RACK  
27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING  
27 15 13 - COMMUNICATIONS COPPER HORIZONTAL CABLING  
27 15 43 - COMMUNICATIONS FACEPLATES & CONNECTORS  
27 16 19 - COMMUNICATIONS PATCH CORDS & STATION CORDS  
27 41 16 - AUDIOVISUAL SYSTEMS

**DIVISION 28 - ELECTRONIC SAFETY AND SECURITY**

28 00 00 - ELECTRONIC SECURITY  
28 13 00 - ACCESS CONTROL AND ALARM MONITORING SYSTEM  
28 16 00 - INTRUSION DETECTION SYSTEM  
28 23 00 - VIDEO SURVEILLANCE SYSTEM  
28 31 00 - DIGITAL ADDRESSABLE FIRE-ALARM SYSTEM

**DIVISION 31 - EARTHWORK**

31 10 00 - SITE CLEARING  
31 23 00 - EARTHWORK  
31 23 33 - TRENCHING BACKFILLING AND COMPACTION

**DIVISION 32 - EXTERIOR IMPROVEMENTS**

32 01 30 - OPERATION AND MAINTENANCE OF SITE IMPROVEMENTS  
32 01 90 - TREE AND SHRUB PRESERVATION  
32 11 23 - AGGREGATE BASE COURSE  
32 12 16 - ASPHALT CONCRETE PAVING  
32 13 13 - SITEWORK CONCRETE  
32 17 13 - PARKING BUMPERS  
32 17 23 - PAVEMENT MARKINGS  
32 17 26 - TACTILE WARNING SURFACING  
32 31 19 - DECORATIVE METAL FENCES AND GATES  
32 84 00 - PLANTING IRRIGATION  
32 90 00 - LANDSCAPE PLANTING  
32 91 13 - SOIL PREPARATION  
32 95 00 - EXTERIOR PLANTING SUPPORT STRUCTURES

**DIVISION 33 - UTILITIES**

33 05 00 - INSTALLATION OF BURIED PIPE  
33 05 13 - MANHOLES AND STRUCTURES  
33 10 00 - WATER DISTRIBUTION  
33 13 00 - DISINFECTION OF WATER UTILITY PIPING SYSTEMS  
33 14 00 - HYDROSTATIC TESTING OF PRESSURE PIPELINES

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33 30 00 - SANITARY SEWER PIPING AND APPURTENANCES  
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33 46 00 - SUBDRAINAGE

DIVISION 34 - TRANSPORTATION

NOT APPLICABLE

DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

NOT APPLICABLE

DIVISION 40 - PROCESS INTEGRATION

NOT APPLICABLE

DIVISION 41 - MATERIAL PROCESSING AND HANDLING EQUIPMENT

NOT APPLICABLE

DIVISION 42 - PROCESS HEATING, COOLING, AND DRYING EQUIPMENT

NOT APPLICABLE

DIVISION 43 - PROCESS GAS AND LIQUID HANDLING, PURIFICATION AND  
STORAGE EQUIPMENT

NOT APPLICABLE

DIVISION 44 - POLLUTION CONTROL EQUIPMENT

NOT APPLICABLE

DIVISION 45 - INDUSTRY-SPECIFIC MANUFACTURING EQUIPMENT

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DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

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DIVISION 48 - ELECTRICAL POWER GENERATION

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SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Contractor's use of site and premises.
  2. Coordination with occupants.
  3. Work restrictions.
  4. Specification and Drawing conventions.

1.02 CONTRACTOR'S USE OF SITE AND PREMISES

- A. Unrestricted Use of Site: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
- B. Restricted Use of Site: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- C. Limits on Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
1. Driveways, Walkways, and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.

1.03 COORDINATION WITH OCCUPANTS

- A. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
- B. Coordinate operations with adjacent YMCA and provide pedestrian and vehicular access at all times for YMCA operations.

1.04 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.
1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.

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- B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7:00 a.m. to 5:00 p.m., Monday through Friday, unless otherwise indicated.
  - 1. No work shall be permitted on City-recognized holidays.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
  - 1. Notify Owner not less than two days in advance of proposed utility interruptions.
  - 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy or adjacent YMCA with Owner or YMCA.
  - 1. Notify Owner or YMCA not less than five days in advance of proposed disruptive operations.
  - 2. Obtain written permission before proceeding with disruptive operations.

1.05 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
  - 2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
  - 3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
  - 4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.
- C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.



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PART 3 - EXECUTION (Not Used)

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SECTION 01 25 00 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.

1.02 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
  2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.03 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
    - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
    - c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
    - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
    - e. Samples, where applicable or requested.
    - f. Certificates and qualification data, where applicable or requested.
    - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
    - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.

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- i. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
  - j. Cost information, including a proposal of change, if any, in the Contract Sum.
  - k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
  - l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
  - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.04 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.05 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.06 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
  - 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
    - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.

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- b. Substitution request is fully documented and properly submitted.
  - c. Requested substitution will not adversely affect Contractor's construction schedule.
  - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
  - e. Requested substitution is compatible with other portions of the Work.
  - f. Requested substitution has been coordinated with other portions of the Work.
  - g. Requested substitution provides specified warranty.
  - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Architect will consider requests for substitution if received within time limits detailed in General Conditions. Requests received after that time may be considered or rejected at discretion of Architect.
- 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
    - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
    - b. Requested substitution does not require extensive revisions to the Contract Documents.
    - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    - d. Substitution request is fully documented and properly submitted.
    - e. Requested substitution will not adversely affect Contractor's construction schedule.
    - f. Requested substitution has received necessary approvals of authorities having jurisdiction.
    - g. Requested substitution is compatible with other portions of the Work.
    - h. Requested substitution has been coordinated with other portions of the Work.
    - i. Requested substitution provides specified warranty.
    - j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.



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SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

1.02 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710.

1.03 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
  - 1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
  - 2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
    - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Include costs of labor and supervision directly attributable to the change.
    - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
    - e. Quotation Form: Use forms acceptable to Architect.
- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.
  - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

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2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 01 25 00 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use form acceptable to Architect.

1.04 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor..

1.05 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive directing Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
  1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
  1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

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PART 3 - EXECUTION (Not Used)

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SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

1.02 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
  - 1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
  - 2. Submit the schedule of values to Architect at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
  - 1. Arrange schedule of values consistent with format of AIA Document G703.
  - 2. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
  - 3. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
    - a. Differentiate between items stored on-site and items stored off-site.
  - 4. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
  - 5. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.03 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.

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- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.
- C. Application for Payment Forms: Use form designated by Architect as form for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
  2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
  3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- E. Transmittal: Submit signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt. One copy shall include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- F. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien in accordance with Owner's requirements and as follows:
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
  2. When an application shows completion of an item, submit conditional final or full waivers.
  3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
  4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
  5. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.
- G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
  2. Schedule of values.
  3. Contractor's construction schedule (preliminary if not final).
  4. Products list (preliminary if not final).
  5. Sustainable design action plans, including preliminary project materials cost data.

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6. Schedule of unit prices.
  7. Submittal schedule (preliminary if not final).
  8. List of Contractor's staff assignments.
  9. List of Contractor's principal consultants.
  10. Copies of building permits.
  11. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
  12. Initial progress report.
  13. Report of preconstruction conference.
  14. Certificates of insurance and insurance policies.
  15. Performance and payment bonds.
  16. Data needed to acquire Owner's insurance.
- H. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
  2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- I. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
  2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
  3. Updated final statement, accounting for final changes to the Contract Sum.
  4. AIA Document G706.
  5. AIA Document G706A.
  6. AIA Document G707.
  7. Evidence that claims have been settled.
  8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
  9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. General coordination procedures.
  - 2. Coordination drawings.
  - 3. RFIs.
  - 4. Project meetings.

1.02 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
  - 1. Preparation of Contractor's construction schedule.
  - 2. Preparation of the schedule of values.
  - 3. Installation and removal of temporary facilities and controls.
  - 4. Delivery and processing of submittals.
  - 5. Progress meetings.
  - 6. Preinstallation conferences.
  - 7. Project closeout activities.
  - 8. Startup and adjustment of systems.

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1.03 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
    - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    - b. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

1.04 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
  2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Owner name.
  2. Owner's Project number.
  3. Name of Architect.
  4. Architect's Project number.
  5. Date.
  6. Name of Contractor.
  7. RFI number, numbered sequentially.
  8. RFI subject.
  9. Specification Section number and title and related paragraphs, as appropriate.
  10. Drawing number and detail references, as appropriate.
  11. Field dimensions and conditions, as appropriate.
  12. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  13. Contractor's signature.

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14. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
  - C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.
  - D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
    1. The following Contractor-generated RFIs will be returned without action:
      - a. Requests for approval of submittals.
      - b. Requests for approval of substitutions.
      - c. Requests for approval of Contractor's means and methods.
      - d. Requests for coordination information already indicated in the Contract Documents.
      - e. Requests for adjustments in the Contract Time or the Contract Sum.
      - f. Requests for interpretation of Architect's actions on submittals.
      - g. Incomplete RFIs or inaccurately prepared RFIs.
    2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
    3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 "Contract Modification Procedures."
      - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within five days of receipt of the RFI response.
  - E. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within three days if Contractor disagrees with response.
- 1.05 PROJECT MEETINGS
- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
  - B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
    1. Attendees: Authorized representatives of Owner Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

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2. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Responsibilities and personnel assignments.
    - b. Tentative construction schedule.
    - c. Critical work sequencing and long lead items.
    - d. Designation of key personnel and their duties.
    - e. Lines of communications.
    - f. Procedures for RFIs.
    - g. Procedures for testing and inspecting.
    - h. Procedures for processing Applications for Payment.
    - i. Distribution of the Contract Documents.
    - j. Submittal procedures.
    - k. Sustainable design requirements.
    - l. Preparation of Record Documents.
    - m. Use of the premises.
    - n. Work restrictions.
    - o. Working hours.
    - p. Owner's occupancy requirements.
    - q. Responsibility for temporary facilities and controls.
    - r. Procedures for moisture and mold control.
    - s. Procedures for disruptions and shutdowns.
    - t. Construction waste management and recycling.
    - u. Parking availability.
    - v. Office, work, and storage areas.
    - w. Equipment deliveries and priorities.
    - x. First aid.
    - y. Security.
    - z. Progress cleaning.
  3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
  2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration.
  3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
  4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.

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5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Conduct progress meetings at regular intervals.
1. Coordinate dates of meetings with preparation of payment requests.
  2. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
  3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
    - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
      - 1) Review schedule for next period.
    - b. Review present and future needs of each entity present, including the following:
      - 1) Interface requirements.
      - 2) Sequence of operations.
      - 3) Resolution of BIM component conflicts.
      - 4) Status of submittals.
      - 5) Status of sustainable design documentation.
      - 6) Deliveries.
      - 7) Off-site fabrication.
      - 8) Access.
      - 9) Site use.
      - 10) Temporary facilities and controls.
      - 11) Progress cleaning.
      - 12) Quality and work standards.
      - 13) Status of correction of deficient items.
      - 14) Field observations.
      - 15) Status of RFIs.
      - 16) Status of Proposal Requests.
      - 17) Pending changes.
      - 18) Status of Change Orders.
      - 19) Pending claims and disputes.
      - 20) Documentation of information for payment requests.
  4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

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- a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
  - 1. Contractor's Construction Schedule.

1.02 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
  - 1. Working electronic copy of schedule file.
  - 2. PDF file.
- B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
- C. Construction Schedule Updating Reports: Submit with Applications for Payment.

1.03 COORDINATION

- A. Coordinate Contractor's Construction Schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.
  - 1. Secure time commitments for performing critical elements of the Work from entities involved.
  - 2. Coordinate each construction activity in the network with other activities, and schedule them in proper sequence.

1.04 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Completion.
  - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
  - 1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
  - 2. Temporary Facilities: Indicate start and completion dates for the following as applicable:
    - a. Securing of approvals and permits required for performance of the Work.

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- b. Temporary facilities.
    - c. Construction of mock-ups, prototypes and samples.
    - d. Owner interfaces and furnishing of items.
    - e. Interfaces with Separate Contracts.
    - f. Regulatory agency approvals.
    - g. Punch list.
  - 3. Procurement Activities: Include procurement process activities for the following long lead-time items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
  - 4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
  - 5. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and Final Completion.
- C. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
- D. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
- 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
  - 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
  - 3. As the Work progresses, indicate Final Completion percentage for each activity.
- E. Distribution: Distribute copies of approved schedule to Architect Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
- 1. Post copies in Project meeting rooms and temporary field offices.
  - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.
- 1.05 GANTT-CHART SCHEDULE REQUIREMENTS
- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for commencement of the Work.

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1. Base schedule on the startup construction schedule and additional information received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
  1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Submittal schedule requirements.
  2. Administrative and procedural requirements for submittals.

1.02 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.03 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

1.04 SUBMITTAL FORMATS

- A. Submittal Information: Include the following information in each submittal:
1. Project name.
  2. Date.
  3. Name of Architect.
  4. Name of Contractor.
  5. Name of firm or entity that prepared submittal.
  6. Names of subcontractor, manufacturer, and supplier.
  7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
  8. Category and type of submittal.
  9. Submittal purpose and description.
  10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.

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11. Drawing number and detail references, as appropriate.
12. Indication of full or partial submittal.
13. Location(s) where product is to be installed, as appropriate.
14. Other necessary identification.
15. Remarks.
16. Signature of transmitter.

- B. Options: Identify options requiring selection by Architect.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1.05 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
  3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
  2. Resubmittal Review: Allow 15 days for review of each resubmittal.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.



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1.06 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
  2. Mark each copy of each submittal to show which products and options are applicable.
  3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts.
    - b. Manufacturer's product specifications.
    - c. Standard color charts.
    - d. Statement of compliance with specified referenced standards.
    - e. Testing by recognized testing agency.
    - f. Application of testing agency labels and seals.
    - g. Notation of coordination requirements.
    - h. Availability and delivery time information.
  4. For equipment, include the following in addition to the above, as applicable:
    - a. Wiring diagrams that show factory-installed wiring.
    - b. Printed performance curves.
    - c. Operational range diagrams.
    - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
  5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Identification of products.
    - b. Schedules.
    - c. Compliance with specified standards.
    - d. Notation of coordination requirements.
    - e. Notation of dimensions established by field measurement.
    - f. Relationship and attachment to adjoining construction clearly indicated.
    - g. Seal and signature of professional engineer if specified.
- C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
  2. Identification: Permanently attach label on unexposed side of Samples that includes the following:



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- a. Project name and submittal number.
  - b. Generic description of Sample.
  - c. Product name and name of manufacturer.
  - d. Sample source.
  - e. Number and title of applicable Specification Section.
  - f. Specification paragraph number and generic name of each item.
3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
- a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
  - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
- a. Number of Samples: Submit full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
- a. Number of Samples: Submit three sets of Samples. Architect will retain one Sample set; remainder will be returned. Retain one returned Sample set as a project record Sample.
    - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
    - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.



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- E. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- F. Certificates:
1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
  2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
  3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
  4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
  5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
  6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- G. Test and Research Reports:
1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
  2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
  3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
  4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.



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5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
  - a. Name of evaluation organization.
  - b. Date of evaluation.
  - c. Time period when report is in effect.
  - d. Product and manufacturers' names.
  - e. Description of product.
  - f. Test procedures and results.
  - g. Limitations of use.

1.07 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
  1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.08 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
  1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

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1.09 ARCHITECT'S REVIEW

- A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required, and return it.
- B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Architect will return without review or discard submittals received from sources other than Contractor.
- F. Submittals not required by the Contract Documents will be returned or discarded by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION



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SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Related Sections:
  - 1. Section 01 43 39.16 "Integrated Exterior Mockups" for integrated exterior mockup assembly requirements.
- C. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
  - 2. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.02 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
  - 1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).



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- D. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
1. Laboratory Mockups: Full-size physical assemblies constructed and tested at testing facility to verify performance characteristics.
  2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
  3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.
- E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.
- F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall have the same meaning as testing agency.
- I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.



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1.03 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Statement: Submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.04 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.05 ACTION SUBMITTALS

- A. Mockup Shop Drawings: For laboratory mockups.
  - 1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
  - 2. Indicate manufacturer and model number of individual components.
  - 3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.06 INFORMATIONAL SUBMITTALS

- A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

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1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
  2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- C. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.07 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
  2. Project title and number.
  3. Name, address, telephone number, and email address of testing agency.
  4. Dates and locations of samples and tests or inspections.
  5. Names of individuals making tests and inspections.
  6. Description of the Work and test and inspection method.
  7. Identification of product and Specification Section.
  8. Complete test or inspection data.
  9. Test and inspection results and an interpretation of test results.
  10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
  11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
  12. Name and signature of laboratory inspector.
  13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Statement on condition of substrates and their acceptability for installation of product.
  2. Statement that products at Project site comply with requirements.
  3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  5. Other required items indicated in individual Specification Sections.

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- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Statement that equipment complies with requirements.
  2. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  3. Other required items indicated in individual Specification Sections.

1.08 QUALITY ASSURANCE

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- G. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.



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- H. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
1. Contractor responsibilities include the following:
    - a. Provide test specimens representative of proposed products and construction.
    - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    - c. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
    - d. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.
  2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- I. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups of size indicated.
  2. Build mockups in location indicated or, if not indicated, as directed by Architect.
  3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
  4. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
  5. Demonstrate the proposed range of aesthetic effects and workmanship.
  6. Obtain Architect's approval of mockups before starting corresponding work, fabrication, or construction.
    - a. Allow seven days for initial review and each re-review of each mockup.
  7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
  8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  10. Demolish and remove mockups when directed unless otherwise indicated.

1.09 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

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1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
  2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
1. Engage a qualified testing agency to perform quality-control services.
    - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
  3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  4. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Contractor-Engaged Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
  3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.
  4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
  5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
  6. Do not perform duties of Contractor.
- E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "Submittal Procedures."

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- F. **Manufacturer's Technical Services:** Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- G. **Contractor's Associated Requirements and Services:** Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
  2. Incidental labor and facilities necessary to facilitate tests and inspections.
  3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
  4. Facilities for storage and field curing of test samples.
  5. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  6. Security and protection for samples and for testing and inspection equipment at Project site.
- H. **Coordination:** Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.10 SPECIAL TESTS AND INSPECTIONS

- A. **Special Tests and Inspections:** Owner will engage a qualified testing agency or special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 REPAIR AND PROTECTION

- A. **General:** On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

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1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching.
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION



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SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.01 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.02 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

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1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.03 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

1.02 USE CHARGES

- A. Installation, removal, and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Architect, testing agencies, and authorities having jurisdiction.

1.03 INFORMATIONAL SUBMITTALS

- A. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- B. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- C. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
  - 1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.
  - 2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
  - 3. Indicate methods to be used to avoid trapping water in finished work.
- D. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
  - 1. Locations of dust-control partitions at each phase of work.
  - 2. HVAC system isolation schematic drawing.
  - 3. Location of proposed air-filtration system discharge.

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4. Waste-handling procedures.
5. Other dust-control measures.

- E. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by the Owner. Include the following:
1. Methods used to meet the goals and requirements of the Owner.
  2. Concrete cutting method(s) to be used.
  3. Location of construction devices on the site.
  4. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.
  5. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with the Owner.

1.04 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and the California Building Code.

1.05 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.01 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

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- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.
- C. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

3.02 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
  - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- C. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- D. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
  - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.03 SUPPORT FACILITIES INSTALLATION

- A. Traffic Controls: Comply with requirements of authorities having jurisdiction.
  - 1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
  - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- B. Parking: Provide temporary offsite or use designated areas of Owner's existing parking areas, if authorized, for construction personnel.
- C. Storage and Staging: Provide temporary offsite area or use designated areas of Project site for storage and staging needs.
- D. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

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1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
  2. Remove snow and ice as required to minimize accumulations.
- E. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
1. Identification Signs: Provide Project identification signs as indicated on Drawings.
  2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
    - a. Provide temporary, directional signs for construction personnel and visitors.
  3. Maintain and touch up signs, so they are legible at all times.
- F. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations.
- 3.04 SECURITY AND PROTECTION FACILITIES INSTALLATION
- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings.
1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
  2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
  3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
  4. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

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- E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- F. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- G. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.
- H. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
  - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- I. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
  - 1. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
  - 2. Insulate partitions to control noise transmission to occupied areas.
  - 3. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
  - 4. Protect air-handling equipment.
  - 5. Provide walk-off mats at each entrance through temporary partition.
- J. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
  - 1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
  - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
  - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
  - 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

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3.05 MOISTURE AND MOLD CONTROL

- A. Moisture and Mold Protection: Protect stored materials and installed Work.
- B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
  - 1. Protect porous materials from water damage.
  - 2. Protect stored and installed material from flowing or standing water.
  - 3. Keep porous and organic materials from coming into prolonged contact with concrete.
  - 4. Remove standing water from decks.
  - 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
  - 1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
  - 2. Keep interior spaces reasonably clean and protected from water damage.
  - 3. Periodically collect and remove waste containing cellulose or other organic matter.
  - 4. Discard or replace water-damaged material.
  - 5. Do not install material that is wet.
  - 6. Discard and replace stored or installed material that begins to grow mold.
  - 7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.
- D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
  - 1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
  - 2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
  - 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
    - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective and require replacing.
    - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
    - c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

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3.06 OPERATION, TERMINATION, AND REMOVAL

- A. Maintenance: Maintain facilities in good operating condition until removal.
  - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- B. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

END OF SECTION

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SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling and comparable products.

1.02 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
  - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
  - 2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.
  - 3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2 "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.
  - 1. Evaluation of Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.



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- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.
- D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
  - 1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
  - 2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.
- E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 01 33 00 "Submittal Procedures."
- F. Substitution: Refer to Section 01 25 00 "Substitution Procedures" for definition and limitations on substitutions.

1.03 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

1.05 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
  - 1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Owner or endorsed by manufacturer to Owner.



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2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of the Owner or endorsed by manufacturer to Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
  3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

## PART 2 - PRODUCTS

### 2.01 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
  4. Where products are accompanied by the term "as selected," Architect will make selection.
  5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
  6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
    - a. Submit additional documentation required by Architect in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by the Architect, whose determination is final.
- B. Product Selection Procedures:
1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
    - a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."



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2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  - a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
  - a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."
4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.
  - a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
  - b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.
5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
  - a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."
6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.
  - a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
  - b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.
7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
  - a. For approval of products by unnamed manufacturers, comply with requirements in Section 01 25 00 "Substitution Procedures" for substitutions for convenience.



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- C. Visual Matching Specification: Where Specifications require the phrase "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
  - 1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.
- E. Sustainable Product Selection: Where Specifications require product to meet sustainable product characteristics, select products complying with indicated requirements. Comply with requirements in Division 01 sustainability requirements Section and individual Specification Sections.
  - 1. Select products for which sustainable design documentation submittals are available from manufacturer.

2.02 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with the following requirements:
  - 1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
  - 2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes, such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
  - 3. Evidence that proposed product provides specified warranty.
  - 4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
  - 5. Samples, if requested.
- B. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation, as specified in Section 01 33 00 "Submittal Procedures."
  - 1. Form of Approval of Submittal: As specified in Section 01 33 00 "Submittal Procedures."



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- 2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- C. Submittal Requirements, Two-Step Process: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.
- D. Submittal Requirements, Single-Step Process: When acceptable to Architect, incorporate specified submittal requirements of individual Specification Section in combined submittal for comparable products. Approval by the Architect of Contractor's request for use of comparable product and of individual submittal requirements will also satisfy other submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION



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SECTION 01 73 00 - EXECUTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
  - 1. Installation of the Work.
  - 2. Progress cleaning.
  - 3. Starting and adjusting.
  - 4. Protection of installed construction.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, and other construction affecting the Work.
  - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
  - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
  - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

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- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

3.03 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Architect promptly.
- B. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- C. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

3.04 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb, and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
  - 4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces, unless otherwise indicated on Drawings.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

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- C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.
- F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
  - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
  - 2. Allow for building movement, including thermal expansion and contraction.
  - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Architect. Fit exposed connections together to form hairline joints.
- J. Repair or remove and replace damaged, defective, or nonconforming Work.

3.05 PROGRESS CLEANING

- A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
  - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  - 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.

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3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
    - a. Use containers intended for holding waste materials of type to be stored.
  - B. Site: Maintain Project site free of waste materials and debris.
  - C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
    1. Remove liquid spills promptly.
    2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
  - D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
  - E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
  - F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
  - G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways.
  - H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
  - I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
  - J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.
- 3.06 STARTING AND ADJUSTING
- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
  - B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

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- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 "Quality Requirements."

3.07 PROTECTION AND REPAIR OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION



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SECTION 01 73 29 - CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
  - 1. Cutting and patching.

1.02 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.03 PREINSTALLATION MEETINGS

- A. Cutting and Patching Conference: Conduct conference at Project site.
  - 1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Inform Architect of scheduled meeting. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:
    - a. Contractor's superintendent.
    - b. Trade supervisor responsible for cutting operations.
    - c. Trade supervisor(s) responsible for patching of each type of substrate.
    - d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affected by cutting and patching operations.
    - e. HVAC shutdown and sealing of air intakes.
  - 2. Coordinate work activities with Owner so Owner has adequate advance notice to place protective dust and water-leakage covers over sensitive equipment and furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below work area.
  - 3. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.04 INFORMATIONAL SUBMITTALS

- A. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
  - 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.



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2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
3. Products: List products to be used for patching and firms or entities that will perform patching work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
  - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

1.05 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
  1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
  2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
  3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
  4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Comply with requirements specified in other Sections.

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- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
  - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.
- C. Fluid-Applied Flashing and Roofing Membrane: Flexible, PMMA-based resin combined with a thixotropic agent for use in combination with non-woven, needle-punched polyester fabric reinforcement to form a monolithic, reinforced flashing and roofing membrane.
  - 1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to the following:
    - a. Kemper System; Kemperol AC Speed FR.
    - b. Siplast; Parapro.
    - c. Soprema; Alsan RS.

## PART 3 - EXECUTION

### 3.01 CUTTING AND PATCHING

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of Work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching in accordance with requirements in Section 01 10 00 "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

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- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
  5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  6. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
  2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
    - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    - b. Restore damaged pipe covering to its original condition.
  3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.
  4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.



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5. Roofing Membrane Assemblies: Patch roofing membrane penetrations and transitions with reinforced, liquid applied PMMA flashing membrane. Embed roofing granules to match existing roofing granule cap and flashing sheets.
6. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

END OF SECTION



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SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
  - 1. Substantial Completion procedures.
  - 2. Final completion procedures.
  - 3. Warranties.
  - 4. Final cleaning.

1.02 ACTION SUBMITTALS

- A. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- B. Certified List of Incomplete Items: Final submittal at Final Completion.

1.03 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.

1.04 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
  - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
  - 2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
  - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.



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4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.
  5. Submit testing, adjusting, and balancing records.
  6. Submit sustainable design submittals not previously submitted.
  7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
  2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
  3. Complete startup and testing of systems and equipment.
  4. Perform preventive maintenance on equipment used prior to Substantial Completion.
  5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 01 79 00 "Demonstration and Training."
  6. Advise Owner of changeover in utility services.
  7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
  8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
  9. Complete final cleaning requirements.
  10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
- 1.05 FINAL COMPLETION PROCEDURES
- A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:
1. Submit a final Application for Payment in accordance with Division 01 Section payment procedures."



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2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report.

- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1.06 LIST OF INCOMPLETE ITEMS

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor, listed by room or space number.
  2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
  3. Include the following information at the top of each page:
    - a. Project name.
    - b. Date.
    - c. Name of Architect.
    - d. Name of Contractor.
    - e. Page number.
  4. Submit list of incomplete items in the following format:
    - a. PDF Electronic File: Architect will return annotated file.

1.07 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- C. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

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PART 2 - PRODUCTS

2.01 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.01 FINAL CLEANING

- A. Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
    - a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
    - b. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    - c. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    - d. Clean flooring, removing debris, dirt, and staining; clean according to manufacturer's recommendations.
    - e. Vacuum and mop concrete.
    - f. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
    - g. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
    - h. Remove labels that are not permanent.
    - i. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

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- j. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
- k. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
- l. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
- m. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
- n. Clean strainers.
- o. Leave Project clean and ready for occupancy.

END OF SECTION



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SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. Systems and equipment operation manuals.
  - 2. Systems and equipment maintenance manuals.
  - 3. Product maintenance manuals.

1.02 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
  - 1. Architect will comment on whether content of operation and maintenance submittals is acceptable.
  - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
  - 1. Submit on digital media acceptable to Architect. Enable reviewer comments on draft submittals.
- C. Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training.

1.03 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
  - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
  - 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

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1.04 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
  2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
  2. Performance and design criteria if Contractor has delegated design responsibility.
  3. Operating standards.
  4. Operating procedures.
  5. Operating logs.
  6. Wiring diagrams.
  7. Control diagrams.
  8. Piped system diagrams.
  9. Precautions against improper use.
  10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
  2. Manufacturer's name.
  3. Equipment identification with serial number of each component.
  4. Equipment function.
  5. Operating characteristics.
  6. Limiting conditions.
  7. Performance curves.
  8. Engineering data and tests.
  9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
  2. Equipment or system break-in procedures.
  3. Routine and normal operating instructions.
  4. Regulation and control procedures.
  5. Instructions on stopping.
  6. Normal shutdown instructions.

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7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.05 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
  2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.
- C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

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- a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
  2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
  3. Identification and nomenclature of parts and components.
  4. List of items recommended to be stocked as spare parts.
- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
  2. Troubleshooting guide.
  3. Precautions against improper maintenance.
  4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  5. Aligning, adjusting, and checking instructions.
  6. Demonstration and training video recording, if available.
- F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
  2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.
- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
1. Do not use original project record documents as part of maintenance manuals.

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1.06 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
  - 1. Product name and model number.
  - 2. Manufacturer's name.
  - 3. Color, pattern, and texture.
  - 4. Material and chemical composition.
  - 5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
  - 1. Inspection procedures.
  - 2. Types of cleaning agents to be used and methods of cleaning.
  - 3. List of cleaning agents and methods of cleaning detrimental to product.
  - 4. Schedule for routine cleaning and maintenance.
  - 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
  - 1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 01 78 36 - WARRANTIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for warranties on products and systems.
- B. Related Sections:
  - 1. Section 01 77 00 "Closeout Procedures" for submitting warranties.

1.02 WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product, system, and installation warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
  - 1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product or system and issued in the name of the Owner or endorsed by manufacturer to Owner.
  - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner for a particular product or system and issued in the name of the Owner or endorsed by manufacturer to Owner.
    - a. Installation Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner for a particular product or system and issued in the name of the Owner or endorsed by installer to Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
  - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  - 2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
  - 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
  - 1. Record Drawings.
  - 2. Record specifications.

1.02 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
  - 1. Number of Copies: Submit one set of marked-up record prints.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and Contract modifications.

1.03 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
  - 1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an acceptable drawing technique.
    - c. Record data as soon as possible after obtaining it.
    - d. Record and check the markup before enclosing concealed installations.
    - e. Cross-reference record prints to corresponding photographic documentation.
  - 2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Dimensional changes to Drawings.
    - b. Revisions to details shown on Drawings.
    - c. Depths of foundations.
    - d. Locations and depths of underground utilities.
    - e. Revisions to routing of piping and conduits.
    - f. Revisions to electrical circuitry.
    - g. Actual equipment locations.
    - h. Duct size and routing.
    - i. Locations of concealed internal utilities.

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- j. Changes made by Change Order or Construction Change Directive.
  - k. Changes made following Architect's written orders.
  - l. Details not on the original Contract Drawings.
  - m. Field records for variable and concealed conditions.
  - n. Record information on the Work that is shown only schematically.
  - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
  - 4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
  - 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
  - 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
- 1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
  - 2. Format: Annotated PDF electronic file.
  - 3. Identification: As follows:
    - a. Project name.
    - b. Date.
    - c. Designation "PROJECT RECORD DRAWINGS."
    - d. Name of Architect.
    - e. Name of Contractor.
- 1.04 RECORD SPECIFICATIONS
- A. Preparation: Mark Specifications to indicate the actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.
- 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  - 2. Note related Change Orders and Record Drawings where applicable.
- B. Format: Submit record specifications as annotated PDF electronic file .
- 1.05 MAINTENANCE OF RECORD DOCUMENTS
- A. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.



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PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SANTEE COMMUNITY CENTER  
CITY OF SANTEE  
100% CONSTRUCTION DOCUMENTS  
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SECTION 01 81 13.71 - SUSTAINABLE DESIGN REQUIREMENTS - CALGREEN  
NON-RESIDENTIAL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General requirements and procedures for compliance with 24 CCR 11, California Green Building Standards Code (CALGreen).
  - 1. Some CALGreen requirements depend on product selections and may not be specifically identified as CALGreen requirements. Compliance with CALGreen requirements may be used as one criterion to evaluate substitution requests and comparable product requests.
  - 2. CALGreen project checklists are attached at the end of this Section for information only.
    - a. Some CALGreen requirements depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.
  - 3. Additional CALGreen requirements not included in this specification apply to the Project.

1.02 DEFINITIONS

- A. CALGreen: California Green Building Standards Code, including supplements in effect as of date of the Contract Documents unless otherwise indicated.
  - 1. Definitions that are part of CALGreen apply to this Section.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site. Review CALGreen requirements and action plans for compliance with requirements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Respond to questions and requests from Architect about CALGreen requirements that depend on product selection or product qualities. Document responses as informational submittals.
- B. Submit documentation to enforcing agency for credits that are the responsibility of Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until enforcing agency has made its determination on Project's CALGreen certification application.
  - 1. Document correspondence with review team, as assigned by the enforcing agency, as informational submittals.

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1.05 INFORMATIONAL SUBMITTALS

- A. Documentation for adhesives and sealants, indicating VOC content.
- B. Documentation for paints and coatings, indicating VOC content.
- C. Documentation for carpet systems, indicating compliance with emissions testing or certification.
- D. Documentation for composite wood products, indicating compliance with emissions testing or certification.
- E. Documentation for resilient flooring, indicating compliance with emissions testing or certification.
- F. Documentation for thermal insulation, indicating compliance with emissions testing or certification.
- G. Documentation for acoustical ceiling panels, indicating compliance with emissions testing or certification.
- H. Documentation for acoustical wall panels, indicating compliance with emissions testing or certification.
- I. Documentation for Construction and Demolition Waste Management: Submit documentation complying with CALGreen for one of the following:
  - 1. Construction Waste Management Plan.
  - 2. Waste Management Company.
  - 3. Waste Stream Reduction Alternative.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Construction and Demolition Waste Management: Achieve end-of-Project rates for salvage/recycling of not less than 80 percent of total nonhazardous solid waste generated by the Work. Comply with local construction and demolition waste management ordinance when it is more stringent.
- B. Universal Waste: Universal Waste items such as fluorescent lamps and ballast, and mercury containing thermostats, as well as other California prohibited Universal Waste materials shall be disposed of properly and diverted from landfills.

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- C. Site-Clearing Waste: 100 percent of trees, stumps, rocks and associated vegetation and soils resulting primarily from land clearing shall be reused or recycled. If contamination by disease or pest infestation is suspected, contact the County Agricultural Commissioner and follow its direction for recycling or disposal of the material.

2.02 MATERIALS

- A. Provide products and procedures necessary to comply with CALGreen requirements in this Section. Although other Sections may specify some requirements that contribute to referenced CALGreen requirements, determine additional materials and procedures necessary to comply with CALGreen requirements indicated.
- B. Recycled Content, Tier 2: The total recycled content value (RCV) of building materials, excluding the structural frame, shall be at least 15 percent of the total material cost of the project, or use three products meeting the minimum recycled content below for at least 75 percent by cost of all products in that category in the project.
1. Fiberglass Insulation: Minimum 30 percent total recycled content with minimum 30 percent post-consumer recycled content.
  2. Cellulose Insulation: Minimum 75 percent total recycled content with minimum 75 percent post-consumer recycled content.
  3. Exterior Latex Paint: Minimum 50 percent total recycled content with minimum 50 percent post-consumer recycled content.
  4. Nylon Carpet: Minimum 10 percent total recycled content with minimum 10 percent post-consumer recycled content.
  5. Compost: Minimum 80 percent total recycled content with minimum 80 percent post-consumer recycled content.
  6. Mulch: Minimum 80 percent total recycled content with minimum 80 percent post-consumer recycled content.
  7. Acoustic Ceiling Panels: Minimum 60 percent total recycled content.
  8. Gypsum Board: Minimum 4 percent total recycled content with minimum 4 percent post-consumer recycled content.
  9. Aggregate Base: Minimum 80 percent total recycled content with minimum 80 percent post-consumer recycled content.

2.03 LOW-EMITTING MATERIALS

- A. Adhesives and Sealants:
1. For field applications, adhesives, adhesive bonding primers, adhesive primers, sealants, sealant primers, and caulks shall comply with VOC content limits of authorities having jurisdiction, or the following VOC content limits:
    - a. Indoor Carpet Adhesives: 50 g/L.
    - b. Carpet Pad Adhesives: 50 g/L.
    - c. Outdoor Carpet Adhesives: 150 g/L.

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- d. Wood Flooring Adhesive: 100 g/L.
- e. Rubber Floor Adhesives: 60 g/L.
- f. Subfloor Adhesives: 50 g/L.
- g. Ceramic Tile Adhesives: 65 g/L.
- h. VCT and Asphalt Tile Adhesives: 50 g/L.
- i. Gypsum Board and Panel Adhesives: 50 g/L.
- j. Cove Base Adhesives: 50 g/L.
- k. Multipurpose Construction Adhesives: 70 g/L.
- l. Structural Glazing Adhesives: 100 g/L.
- m. Single-Ply Roof Membrane Adhesive: 250 g/L.
- n. Other Adhesive Not Specifically Listed: 50 g/L.
- o. PVC Welding Compounds: 510 g/L.
- p. CPVC Welding Compounds: 490 g/L.
- q. ABS Welding Compounds: 325 g/L.
- r. Plastic Cement Welding Compounds: 250 g/L.
- s. Adhesive Primer for Plastic: 550 g/L.
- t. Contact Adhesive: 80 g/L.
- u. Special-Purpose Contact Adhesive (Contact Adhesive That Is Used to Bond Melamine Covered Board, Metal, Unsupported Vinyl, Rubber, or Wood Veneer 1/16 Inch or Less in Thickness to Any Surface): 250 g/L.
- v. Structural Wood Member Adhesives: 140 g/L.
- w. Top and Trim Adhesive: 250 g/L.
- x. Metal-to-Metal Adhesives: 30 g/L.
- y. Plastic Foam Adhesives: 50 g/L.
- z. Adhesives for Porous Materials (except Wood): 50 g/L.
- aa. Wood Glues: 30 g/L.
- bb. Fiberglass Adhesives: 80 g/L.
- cc. Architectural Sealants: 250 g/L.
- dd. Nonmembrane Roof Sealants: 300 g/L.
- ee. Roadway Sealants: 250 g/L.
- ff. Single-Ply Roof Membrane Sealants: 450 g/L.
- gg. Other Sealants: 420 g/L.
- hh. Sealant Primers for Nonporous Substrates: 250 g/L.
- ii. Sealant Primers for Porous Substrates: 775 g/L.
- jj. Modified Bituminous Sealant Primers: 500 g/L.
- kk. Other Sealant Primers: 750 g/L.
- 2. Prohibited Ingredients: Adhesives and sealants must not contain the following:
  - a. Chloroform.
  - b. Ethylene dichloride.
  - c. Methylene chloride.
  - d. Perchloroethylene.
  - e. Trichloroethylene.

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3. Additional Requirements: Comply with additional requirements in CALGreen for aerosol adhesives, and small unit sizes of adhesives, and sealant or caulking compounds.

B. Paints and Coatings:

1. For field applications, paints and coatings shall comply with VOC limits of California Air Resources Board (CARB) Architectural Coatings Suggested Control Measure (SCM) below, unless more stringent local limits apply. The VOC content limit for coatings that do not meet the definitions for the specialty coatings categories listed shall be determined by classifying the coating as flat, nonflat, or nonflat-high gloss coating, based on its gloss.
  - a. Flat Coatings: 50 g/L.
  - b. Nonflat Coatings: 100 g/L.
  - c. Nonflat - High Gloss Coatings: 150 g/L.
  - d. Specialty Coatings:
    - 1) Aluminum Roof Coatings: 400 g/L.
    - 2) Basement Special Coatings: 400 g/L.
    - 3) Bituminous Roof Coatings: 50 g/L.
    - 4) Bituminous Roof Primers: 350 g/L.
    - 5) Bond Breakers: 350 g/L.
    - 6) Concrete Curing Compounds: 350 g/L.
    - 7) Concrete/Masonry Sealers: 100 g/L.
    - 8) Driveway Sealers: 50 g/L.
    - 9) Dry-Fog Coatings: 150 g/L.
    - 10) Faux Finishing Coatings: 350 g/L.
    - 11) Fire-Resistive Coatings: 350 g/L.
    - 12) Floor Coatings: 100 g/L.
    - 13) Form-Release Compounds: 250 g/L.
    - 14) Graphic Arts Coatings (Sign Paints): 500 g/L.
    - 15) High-Temperature Coatings: 420 g/L.
    - 16) Industrial Maintenance Coatings: 250 g/L.
    - 17) Low Solids Coatings: 120 g/L.
    - 18) Magnesite Cement Coatings: 450 g/L.
    - 19) Mastic Texture Coatings: 100 g/L.
    - 20) Metallic Pigmented Coatings: 500 g/L.
    - 21) Multi-Color Coatings: 250 g/L.
    - 22) Pretreatment Wash Primers: 420 g/L.
    - 23) Primers, Sealers, and Undercoaters: 100 g/L.
    - 24) Reactive Penetrating Sealers: 350 g/L.
    - 25) Recycled Coatings: 250 g/L.
    - 26) Roof Coatings: 50 g/L.
    - 27) Rust-Preventive Coatings: 250 g/L.
    - 28) Shellacs, Clear: 730 g/L.
    - 29) Shellacs, Opaque: 550 g/L.
    - 30) Specialty Primers, Sealers and Undercoaters: 100 g/L.

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- 31) Stains: 250 g/L.
  - 32) Stone Consolidants: 450 g/L.
  - 33) Swimming Pool Coatings: 340 g/L.
  - 34) Traffic Marking Coatings: 100 g/L.
  - 35) Tub and Tile Refinish Coatings: 420 g/L.
  - 36) Waterproof Membranes: 250 g/L.
  - 37) Wood Coatings: 275 g/L.
  - 38) Wood Preservatives: 350 g/L.
  - 39) Zinc-Rich Primers: 340 g/L.
2. Additional Requirements: Comply with additional requirements in CALGreen for aerosol paints and coatings.
- C. Carpet Systems: All interior carpet materials, including cushion, shall comply with at least one of the following:
- 1. Carpet and Rug Institute's Green Label Plus program.
  - 2. VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2).
- D. Composite Wood Products: Composite wood products used on the interior or exterior of the building shall have formaldehyde emission rates not greater than the following specified by the California Air Resources Board (CARB), Air Toxics Control Measure (ATCM) for Composite Wood, as tested in accordance with ASTM E1333:
- 1. Hardwood Plywood (Veneer Core and Composite Core): 0.05 ppm.
  - 2. Particleboard: 0.09 ppm.
  - 3. Medium-Density Fiberboard More Than 5/16 Inch Thick: 0.11 ppm.
  - 4. Medium-Density Fiberboard 5/16 Inch or Less in Thickness: 0.13 ppm.
- E. Resilient Flooring Systems, Tier 2: Where resilient flooring is installed, 100 percent of floor area receiving resilient flooring shall meet the requirements comply with the following:
- 1. VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2).
- F. Thermal Insulation; Tier 2: Thermal insulation products shall be free of added formaldehyde and shall comply with VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2).

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- G. Acoustical Ceilings and Wall Panels: Acoustical ceilings and wall panels shall comply with VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2).

PART 3 - EXECUTION

3.01 CONSTRUCTION WASTE MANAGEMENT

- A. Construction and Demolition Waste Management: Achieve specified rates for waste management by one of the following:
1. Construction Waste Management Plan: Where a local jurisdiction does not have a construction and demolition waste management ordinance that is more stringent, submit a construction waste management plan that includes the following:
    - a. Identification of construction and demolition waste materials to be diverted from disposal by efficient usage, recycling, reuse on the Project or salvage for future use or sale.
    - b. Determination of construction and demolition waste materials will be sorted on-site (source separated) or bulk mixed (single stream).
    - c. Identification of diversion facilities where construction and demolition waste material collected will be taken.
    - d. Specification of the amount of construction and demolition waste materials diverted shall be taken by weight or volume, but not by both.
  2. Waste Management Company: Utilize a waste management company that can provide verifiable documentation that the percentage of construction and demolition waste material diverted from the landfill complies with CALGreen.
  3. Waste Stream Reduction Alternative: The combined weight of new construction disposal that does not exceed two pounds per square foot of building area shall be deemed to meet the 65 percent minimum requirement as approved by the enforcing agency.

3.02 CONSTRUCTION IAQ MANAGEMENT

- A. Cover or close openings in ducts and other related air-distribution component openings with tape, plastic, sheet metal, or other approved method before beginning dust-producing operations and maintain until dust-producing operations are complete.
- B. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period, as specified in Section 01 50 00 "Temporary Facilities and Controls," install MERV 8 filter media according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
1. Replace all air filters immediately prior to occupancy.

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END OF SECTION

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SECTION 02 41 19 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Demolition and removal of selected portions of building or structure.
  - 2. Demolition and removal of selected site elements.
  - 3. Salvage of existing items to be reused or recycled.

1.02 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.03 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.04 FIELD CONDITIONS

- A. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
  - 1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- B. Storage or sale of removed items or materials on-site is not permitted.
- C. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
  - 1. Maintain fire-protection facilities in service during selective demolition operations.

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1.05 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.06 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

3.02 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
  - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
  - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
  - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
    - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

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- b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
- c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
- g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.03 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
  - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
  - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
  - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
  - 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.04 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
  - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.



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2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
  3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
  5. Maintain fire watch during and after flame-cutting operations.
  6. Maintain adequate ventilation when using cutting torches.
  7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
  8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
  9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
  10. Dispose of demolished items and materials promptly.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Salvaged Items:
1. Clean salvaged items.
  2. Pack or crate items after cleaning. Identify contents of containers.
  3. Store items in a secure area until delivery to Owner.
  4. Transport items to Owner's storage area designated by Owner.
  5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
  2. Pack or crate items after cleaning and repairing. Identify contents of containers.
  3. Protect items from damage during transport and storage.
  4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.



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3.05 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
- D. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.
- E. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight.

3.06 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
  - 1. Do not allow demolished materials to accumulate on-site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.

3.07 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION



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SECTION 03 15 00 - CONCRETE ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Waterstops.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 WATERSTOPS

- A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete (19 by 25 mm).
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Carlisle Coatings & Waterproofing, Inc.; MiraSTOP.
    - b. CETCO; Volclay Waterstop-RX.
    - c. Concrete Sealants Inc.; Conseal CS-231.
    - d. Greenstreak; Swellstop.
    - e. Henry Company, Sealants Division; Hydro-Flex.
    - f. JP Specialties, Inc.; Earth Shield Type 20.
  2. Locations: For joints in 8-inch or greater concrete with a minimum concrete coverage of 3 inches and subject to a hydrostatic head no greater than 200 feet.
- B. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic rubber, for adhesive bonding to concrete.
1. Product: Adeka; KBA-1510FP.
  2. Locations: For joints in 4-inch or greater concrete with a minimum concrete coverage of 1 inch and subject to a hydrostatic head no greater than 25 feet.

PART 3 - EXECUTION

3.01 WATERSTOPS

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

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- B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

END OF SECTION



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SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  - 1. Related sections:
    - a. Documents affecting work of this Section include, but are not necessarily limited to the County's administrative requirements.
    - b. 32 12 16 Asphalt Concrete Paving
- B. Latest edition of American Concrete Institute, ACI 318 and Manual of Concrete Practice (inclusive of all Parts).
- C. If conflict occurs between the Contract Drawings, the Project Manual, ACI 318, and the Manual of Concrete Practice, the most stringent takes precedence.

1.02 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.03 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
- B. Shore: Vertical or inclined support members designed to carry the weight of formwork, concrete, and construction loads above.
- C. Strength Test: The average of the strengths of at least two 6 by 12 inch cylinders or at least three 4 by 8 inch cylinders made from the same sample of concrete and tested at 28 days or at test age designated for determination of specified compressive strength of concrete.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.



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- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
  - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
  - 2. Include qualified strength test records if design mixture is based on field experience.
  - 3. Include results of trial mixtures if design mixture is based on trial mixtures.
  - 4. Include results of modulus of elasticity tests on trial mixtures.
  - 5. Design mixture to be signed and sealed by a professional Civil or Structural Engineer licensed in the State in which the Project is constructed.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

1.05 INFORMATION SUBMITTALS

- A. Qualification Data: For Installers.
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
  - 1. Cementitious materials.
  - 2. Admixtures.
  - 3. Form materials and form-release agents.
  - 4. Steel reinforcement and accessories.
  - 5. Curing compounds.
  - 6. Floor and slab treatments.
  - 7. Bonding agents.
  - 8. Vapor retarders, including subbase materials.
  - 9. Semirigid joint filler.
  - 10. Joint-filler strips.
  - 11. Repair materials.
- D. Material Test Reports: For the following, from a qualified Testing Agency, indicating compliance with requirements:
  - 1. Aggregates.
- E. ICC ES Evaluation Reports: For evidence of Building Code compliance:
  - 1. Mechanical splices and connectors for reinforcing steel.
- F. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.



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- G. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
  - 1. Location of construction joints is subject to approval of the Architect.

- H. Minutes of preinstallation conference.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs a Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel.
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
  - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- F. Concrete Testing Service: Engage a qualified independent Testing Agency to perform material evaluation tests and to design concrete mixtures.
- G. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review special inspection and Testing Agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.



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1.07 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PART 2 – PRODUCTS

2.01 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
  - 1. Plywood, metal, or other approved panel materials.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- E. Void Forms: Structurally sufficient to support weight of plastic concrete and other superimposed loads.
  - 1. Expanded polystyrene (EPS); ASTM C578, Type XI.
  - 2. Geofoam (where indicated on drawings), Type EPS22, ASTM D6817, ICC-ES #1006.
- F. Chamfer Strips: Wood, metal, PVC, or rubber strips.
- G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.



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2.02 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 60 percent.
- B. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- C. Low-Alloy-Steel Weldable Reinforcing Bars: ASTM A706/A706M, Grade 60, deformed.
- D. Plain-Steel Welded Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.03 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Dowel Bar Sleeves: Circular PVC sleeve, sealed one end, dowel bar embedment plus 1 inch in length, and 1/16 inch annular space inside diameter.
- C. Deformed Bar Anchors: ASTM A1064/A1064M, deformed steel wire; AWS D1.1/D1.1M, Type C.
- D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
  - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
- E. Mechanical Splices and Connectors: Comply with ACI 318 and ACI 439.3R, Type II.
  - 1. Furnish splicing and connector system with current ICC ES Evaluation Report.

2.04 CONCRETE MATERIALS

- A. Regional Materials: Provide concrete that has been manufactured within 500 miles of Project site from aggregates and/or cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
  - 1. Portland Cement: ASTM C150/C150M, Type as indicated. Supplement with the following.
    - a. Fly Ash: ASTM C618, Class F.



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- C. Normal-Weight Aggregates: ASTM C33/C33M, Class 1N coarse aggregate, well-graded. Provide aggregates from a single source.
  - 1. Maximum Coarse Aggregate Size: 1-1/2 inches nominal.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Lightweight Aggregate: ASTM C330/C330M, expanded shale, presize before firing, 3/4-inch nominal maximum aggregate size.
- E. Water: ASTM C 94/C94M.

2.05 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C260/C260M.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
  - 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
  - 2. Retarding Admixture: ASTM C494/C494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
  - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.

2.06 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E1745, Class A, 15 mil. Include manufacturer's recommended adhesive or pressure-sensitive tape.
- B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
- C. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D448, Size 10, with 100 percent passing a 3/8-inch sieve, 10 to 30 percent passing a No. 100 sieve, and at least 5 percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C33/C33M for fine aggregates.

2.07 FLOOR AND SLAB TREATMENTS

- A. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.



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- B. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

2.08 LIQUID FLOOR TREATMENTS

- A. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2.09 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Water: Potable.
- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

2.10 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D2240.
- C. Reglets: Fabricate reglets in concrete to receive flashing from other trades of not less than 0.022-inch thick galvanized-steel sheet. See Division 07 Section "Sheet Metal Flashing and Trim". Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- D. Dovetail Anchor Slots: Provide as shown on Drawings. Hot-dip galvanized-steel sheet, not less than 0.034-inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.



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2.11 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
  2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
  4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
  2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
  4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C109/C109M.

2.12 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete indicated on drawings, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
1. Use a qualified independent Testing Agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures
- B. Modulus of Elasticity: Modulus of elasticity tests (ASTM C469/C469M) shall be performed on laboratory trial mixtures for each concrete strength, each concrete mix design and for each aggregate source. Modulus of elasticity to be tested using servo controlled electromechanical United machines or servo controlled hydraulic Satec machines. Maintain rate of loading to  $35 \pm 4$  psi in lieu of that specified in ASTM C469/C469M.
1. The modulus of elasticity (psi) at 28 days shall be a minimum of 100% of the target modulus of elasticity.
  2. Target modulus of elasticity (psi):
    - a. For  $f'_c \leq 6,000$  psi:  $57,000 (f'_c f'_c)^{1/2}$
    - b. For  $f'_c > 6,000$  psi:  $40,000 (f'_c)^{1/2} + 1 \times 10^6$
    - c.  $f'_c$  is the specified concrete strength in psi at 28 days.



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3. A modulus of elasticity test shall be the average modulus of elasticity from a set of two (minimum) specimens obtained from same sample.
  4. Use a qualified independent Testing Agency for preparing and reporting results of modulus of elasticity tests.
- C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 25 percent maximum
    - a. Fly ash is not permitted in suspended slabs.
- D. Water-soluble chloride ion content shall be determined by ASTM C1218/C1218M at age between 28 and 42 days. Submit documentation verifying compliance. Limit water-soluble, chloride-ion content in hardened concrete to:
1. 1.00 percent by weight of cement for mild-reinforced concrete.
  2. 0.06 percent by weight of cement for post-tensioned concrete.
- E. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing admixture in concrete, as required, for placement and workability.
  2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
  3. Use water-reducing admixture in pumped concrete, concrete for parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.13 FABRICATION REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M, and furnish batch ticket information.
1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - PART 3 – EXECUTION

3.01 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.



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- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117, unless specified otherwise in the Contract Documents.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
  - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
  - 2. Class B, 1/4 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
  - 1. Install keyways, reglets, recesses, and the like, for easy removal.
  - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete, unless otherwise indicated on Drawings.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.



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3.02 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303 "Code of Standard Practice for Steel Buildings and Bridges."

3.03 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
  - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved its 28-day design compressive strength.
  - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.04 VAPOR RETARDERS

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E1643 and manufacturer's written instructions.
  - 1. Lap joints 6 inches and seal with manufacturer's recommended tape.
- B. Granular Course: Placement as noted on drawings, 4-inch bed of granular fill, material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.
  - 1. Fine-Graded Granular Material: Place and compact a 1/2-inch layer of fine-graded granular material over granular fill.

3.05 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.



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1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
  1. Weld reinforcing bars according to AWS D1.4/D1.4M, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.06 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
  2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
  3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
  1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
  2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.



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- a. Perform saw-cutting before concrete starts to cool, as soon as the concrete surface is firm enough not to be torn or damaged by the blade, and before random drying-shrinkage cracks can form in the concrete slab. Joints produced by conventional dry- or wet-cut process shall be made within 4 hours in hot weather and within 12 hours in cold weather after the slab has been finished.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
  - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
  - 2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint or use PVC dowel bar sleeve.

3.07 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
  - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
  - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
  - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.



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- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  2. Maintain reinforcement in position on chairs during concrete placement.
  3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  4. Deviation from cross sectional thickness of suspended slabs shall not exceed  $\pm 1/4"$ .
  5. Deviation from elevation of suspended slabs before removal of supporting shores shall not exceed  $+3/8"$  nor  $-1/4"$ .
  6. Slope surfaces uniformly to drains where required.
  7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- F. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.08 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces not exposed to view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.



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1. Apply to concrete surfaces exposed to view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
  1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.09 FINISHING FLOOR AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
  1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
  1. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, or built-up or membrane roofing.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
  1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
  2. Finish surfaces to the following tolerances, according to ASTM E1155, for a randomly trafficked floor surface:
    - a. Specified overall values (SOV) of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values (MLV) of flatness, F(F) 17; and of levelness, F(L) 15.



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- b. Specified overall values (SOV) of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values (MLV) of flatness, F(F) 24; and of levelness, F(L) 17; for surfaces to receive thin-set flooring.
  - 3. For floor installations 10,000 sq. ft. or less in total project area, finish and measure surface so gap at any point between concrete surface and an unveled, freestanding, 10-ft.long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch (90 percent compliance) in accordance to ACI 117 Section 4.8.
  - E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
    - 1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
  - F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
    - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
  - G. Slip-Resistive Finish: Before final floating, apply slip-resistive aluminum granule finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
    - 1. Uniformly spread 25 lbs./100 sq. ft. of dampened slip-resistive aluminum granules over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
    - 2. After broadcasting and tamping, apply float finish.
    - 3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aluminum granules.
  - H. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows.
    - 1. Uniformly apply dry-shake floor hardener at a rate of 100 lbs./100 sq. ft. unless greater amount is recommended by manufacturer.
    - 2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
    - 3. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.
- 3.10 MISCELLANEOUS CONCRETE ITEMS
- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as



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specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.11 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials.
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.



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2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
  - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
  - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
  - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

### 3.12 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
  1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
  2. Do not apply liquid to concrete sooner than that recommended by manufacturer.
  3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

### 3.13 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.



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3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
  - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
  - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
  - 4. Repair technique shall be tested on a mockup or surface to be concealed later, before repairing surfaces exposed to view, for approval by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
  - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  - 2. After concrete has cured at least 14 days, correct high areas by grinding.
  - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.



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4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified Testing Agency to perform field tests and inspections and prepare test reports.
- B. Inspections: Verify and inspect concrete Work as shown on Drawings.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:
  1. Testing Frequency: Obtain at least one random composite sample for each 150 cu. yd. of concrete or 5,000 sq. ft. of surface area of slabs of walls, or fraction thereof, of each concrete mixture placed each day.
    - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at



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least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M, pressure method, for normal-weight concrete; [ASTM C173/C173M, volumetric method, for structural lightweight concrete; ]one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Unit Weight: ASTM C567/C567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
6. Compression Test Specimens: ASTM C31/C31M.
  - a. Mild-Reinforced Slabs and Beams: Cast and laboratory-cure five standard cylinder plus one spare standard cylinder specimens for each composite sample.
    - 1) Cast and field-cure additional standard cylinder specimens to verify concrete strength for removal of shoring and reshoring in multistory construction. Number of field-cured cylinder specimens to be determined by Contractor.
  - b. Walls and Columns: Cast and laboratory-cure five standard cylinder plus one spare standard cylinder specimens for each composite sample.
  - c. Other Concrete Elements: Cast and laboratory-cure four standard cylinder plus one spare standard cylinder specimens for each composite sample.
7. Compressive-Strength Tests: ASTM C39/C39M.
  - a. Mild-Reinforced Concrete Slabs and Beams: Test one laboratory-cured specimen at 4 days; one laboratory-cured specimen at 7 days or upon formwork stripping, whichever comes first; one laboratory-cured specimen at 14 days; and two laboratory-cured specimens at 28 days.
  - b. Walls, Columns and concrete pilaster: Test one laboratory-cured specimen at 7 days, one laboratory-cured specimen at 56 days and one laboratory-cured specimen at 90 days; and two laboratory-cured specimens at 28 days.
  - c. Other Concrete Elements: Test two laboratory-cured specimens at 7 days and two laboratory-cured specimens at 28 days.
  - d. A compressive-strength test at shall be the average compressive strength from a set of two specimens obtained from same composite and tested at the age indicated.



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8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
  - a. If 28-day compressive-strength test falls below satisfactory levels, strength test the spare cylinder at age determined by the Contractor and average with the strength of the 28-day specimens. The average strength of the three cylinders shall be considered one compressive-strength test.
9. Modulus of Elasticity Test Specimens: ASTM C31/C31M.
  - a. Shear walls, columns and concrete pilasters: Cast and field-cure eight two standard cylinder specimens plus two spares for each composite sample.
    - 1) Composite samples (consisting of 10 standard field-cured cylinder specimens) for each concrete strength, each concrete mix design and for each aggregate source, shall be randomly selected from every five floors, with two random composite samples minimum per building.
10. Modulus of Elasticity Tests: ASTM C469/C469M. Modulus of elasticity to be tested using servo controlled electromechanical United machines or servo controlled hydraulic Satec machines. Maintain rate of loading to  $35 \pm 4$  psi in lieu of that specified in ASTM C469/C469M.
  - a. Mild-Reinforced and Post-Tensioned Slabs and Beams: Test two field-cured specimens at 2 days, 4 days, 7 days, 14 days, and 28 days.
  - b. Columns and Shear Walls: Test two field-cured specimens at 7 days, 28 days, 56 days, and 90 days.
  - c. A modulus of elasticity test shall be the average modulus of elasticity from a set of two specimens obtained from same composite sample and tested at age indicated.
  - d. If modulus of elasticity of two specimens varies by more than 15% a spare cylinder shall be tested. The average modulus of elasticity of three specimens shall be considered the modulus of elasticity.
  - e. Modulus of elasticity tests are required for each concrete strength, each concrete mix design and for each aggregate source.
11. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing.
  - a. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete Testing Agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for each age tested.
  - b. Reports of modulus of elasticity tests shall contain Project identification name and number, mix identification number, specimen identification number, curing and environmental history of specimen, date of test, name



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of Testing Agency, and plot of the results with age of concrete as the abscissa and modulus of elasticity as the ordinate.

12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests: Testing Agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing Agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

- D. Measure floor and slab flatness and levelness according to ASTM E1155 within 24 hours of finishing.

3.16 PROTECTION OF LIQUID FLOOR TREATMENTS

- A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION



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SECTION 03 35 03 - CONCRETE SLAB FINISHING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Concrete finish requirements for unformed horizontal concrete surfaces. This section supplements requirements of Division 03 Section "Cast-In-Place Concrete."
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for sealers, indicating VOC content.

1.04 QUALITY ASSURANCE

- A. Standards: Comply with the following documents, except where requirements of the contract documents are more stringent:
  - 1. ACI 301.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Sealers:
    - a. VOC content limits for field applications within the weatherproofing system.

2.02 CONCRETE SLAB SEALER

- A. Concrete Slab Sealer: Liquid chemical hardener; enhanced silicate or silicate type.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Curecrete Chemical; Ashford Formula.

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- b. Dayton Superior; Sure Hard Densifier J17.
- c. Laticrete; L&M Lion Hard.

2.03 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified product that can be applied in thicknesses from a feathered edge to 1/2 inch to match adjacent floor elevations.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Ardex; Feather Finish.
    - b. Dayton Superior; Sure Finish.
    - c. Laticrete; Supercap.
  - 2. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
  - 3. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  - 4. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
  - 5. Compressive Strength: Not less than 4100 psi at 28 days when tested in accordance with ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Ardex.
    - b. Dayton Superior.
    - c. Laticrete.
  - 2. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
  - 3. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  - 4. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
  - 5. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.04 MISCELLANEOUS MATERIALS AND ACCESSORIES

- A. Contraction Joint Filler:
  - 1. Sealant: As specified in Section 07 92 00.
- B. Concrete Cleaner: Liquid concentrate, biodegradable, heavy-duty cleaner-degreaser compound.

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PART 3 - EXECUTION

3.01 FINISHING SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in 1 direction.
  - 1. Apply scratch finish to surfaces as follows:
    - a. To receive concrete floor toppings.
    - b. To receive mortar setting beds for bonded cementitious floor finishes.
    - c. Other surfaces indicated.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
  - 1. Apply float finish to surfaces as follows:
    - a. To receive trowel finish.
    - b. To be covered with fluid-applied or sheet waterproofing.
    - c. Other surfaces indicated.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
  - 1. Apply trowel finish to surfaces as follows:
    - a. Exposed to view.
    - b. To receive concrete sealer.
    - c. To receive polishing.
    - d. To be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage/waterproofing/crack-isolation membrane, paint, or another thin-film-finish coating system.
    - e. Other surfaces as indicated.
  - 2. Finish surfaces to the following Specified Overall Value (SOV) and Minimum Local Value (MLV) tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
    - a. Carpeted Floors: Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.
    - b. Polished Concrete Floors: Specified overall values of flatness, F(F) 40; and of levelness, F(L) 30; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 20.



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- c. Other Floors at Slabs on Grade: Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
      - d. Other Floors at Suspended Slabs: Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.
    - 3. F(L) tolerances do not apply to randomly trafficked floor surfaces that are inclined or cambered.
    - 4. F(L) tolerances do not apply to shored, elevated construction after shoring has been removed.
  - E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces. While concrete is still plastic, slightly scarify surface with a fine broom.
    - 1. Apply trowel and fine broom finish to surfaces as follows:
      - a. To receive ceramic or quarry tile installed by either thickset or thin-set method.
      - b. To receive traffic coatings.
      - c. Exposed interior stair treads/landings, steps, and ramps.
      - d. Other surfaces indicated.
    - 2. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
  - F. Broom Finish: Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
    - 1. Apply broom finish to surfaces as follows:
      - a. Exterior concrete platforms, steps, and ramps.
      - b. Other surfaces indicated.
  - G. Float and Broom Finish: After applying float finish, begin second floating operation to surfaces when bleed water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations and apply broom finish as follows:
    - 1. Apply float and broom finish to surfaces as follows:
      - a. Parking garage slabs and ramps.
    - 2. Apply a fine broom finish at parking garage slabs by drawing a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
    - 3. Apply a coarse broom finish at parking garage ramps and turns by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.
- 3.02 REPAIRING SLAB SURFACES
- A. Repairing Unformed Surfaces:
    - 1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
      - a. Correct low and high areas.



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- b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
  - 2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  - 3. After concrete has cured at least 14 days, correct high areas by grinding.
  - 4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
    - a. Finish repaired areas to blend into adjacent concrete.
  - 5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
    - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    - b. Feather edges to match adjacent floor elevations.
  - 6. Correct other low areas scheduled to remain exposed with repair topping.
    - a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
    - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  - 7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
    - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
    - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
    - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
    - d. Place, compact, and finish to blend with adjacent finished concrete.
    - e. Cure in same manner as adjacent concrete.
  - 8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
    - a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
    - b. Dampen cleaned concrete surfaces and apply bonding agent.
    - c. Place patching mortar before bonding agent has dried.
    - d. Compact patching mortar and finish to match adjacent concrete.
    - e. Keep patched area continuously moist for at least 72 hours.
- B. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.



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- C. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.03 SEALED CONCRETE FLOORS

- A. Concrete Slab Sealer:
1. Apply sealer/finish following manufacturer's printed application instructions; apply single saturation coat.
  2. Remove surplus sealer/hardener and rinse according to manufacturer's instructions.
  3. Burnishing: Prior to substantial completion, apply light second coat of chemical sealer-hardener material and polish using mild abrasives or brushes in accordance with sealer/hardener manufacturer's recommendations. Buff to even satin sheen.
  4. Location: At all interior, exposed slabs subject to pedestrian traffic, unless indicated otherwise.

3.04 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
1. Coordinate floor and slab flatness and levelness testing with Owner's testing agency according to ASTM E 1155 within 48 hours of finishing.

END OF SECTION



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SECTION 03 35 07 - FORMED CONCRETE FINISHING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Formed concrete surfaces of completed structure or building, exposed to view, that require special finishing to obtain specified architectural appearance. This section supplements requirements of Division 03 Section "Cast-In-Place Concrete."

1.02 QUALITY ASSURANCE

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 and Section 6, "Architectural Concrete."
  - 2. ACI 303.1, "Specification for Cast-in-Place Architectural Concrete."

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Form Tie Plugs: Polymer modified mortar plug designed to patch tie holes created by form tie cones.
  - 1. Basis-of-Design Product: A54 Snaplug Concrete Plug by Dayton Superior.
  - 2. Adhesive: Manufacturer's recommended adhesive approved for intended purpose.

PART 3 - EXECUTION

3.01 FINISHES, GENERAL

- A. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.
  - 1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.
- B. Maintain uniformity of special finishes over construction joints unless otherwise indicated.

3.02 AS-CAST FORMED FINISHES

- A. Produce as-cast formed finishes in accordance with ACI 301 and as follows:
  - 1. Surface Finish 1.0 (SF-1):

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- a. Patch voids larger than 1-1/2 inch wide or 1/2 inch deep.
  - b. Remove projections larger than 1 inch.
  - c. Tie holes to remain unpatched.
  - d. Provide surface tolerance Class D in accordance with ACI 117.
  - e. Apply to concrete surfaces not exposed to public view.
2. Surface Finish 2.0 (SF-2):
- a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
  - b. Remove projections larger than 1/4 inch.
  - c. Patch tie holes.
  - d. Provide surface tolerance Class B in accordance with ACI 117.
  - e. Apply to concrete surfaces exposed to public view,.
3. Surface Finish 3.0 (SF-3):
- a. Patch voids larger than 5/8 inch wide or 1/2 inch deep.
  - b. Remove projections larger than 1/8 inch.
  - c. Patch tie holes.
  - d. Provide surface tolerance Class A in accordance with ACI 117.
  - e. Apply to concrete surfaces to be covered with a coating or covering material applied directly to concrete.

3.03 FORMED CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
1. Immediately after form removal, cut out honeycombs, rock pockets, and voids. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
  3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance.



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3.04 FORM TIE HOLE PLUG INSTALLATION

- A. Installation: Plug form tie holes with form tie hole plugs using adhesive, in accordance with manufacturer's instructions.

3.05 FIELD QUALITY CONTROL

- A. General: Comply with field quality-control requirements in Division 03 Section "Cast-in-Place Concrete."

3.06 PROTECTION, AND CLEANING

- A. Protect corners, edges, and surfaces from damage; use guards and barricades.
- B. Protect concrete from staining, laitance, and contamination during remainder of construction period.
- C. Clean concrete surfaces after finish treatment to remove stains, markings, dust, and debris.

END OF SECTION



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SECTION 03 35 43 - POLISHED CONCRETE FINISHING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Polished concrete finishing.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
  - 2. Section 03 30 00 "Cast-in-Place Concrete" for concrete for polished concrete, including concrete materials, mixture design, placement procedures, and curing.
  - 3. Section 03 35 03 "Concrete Slab Finishing" for flatness and levelness requirements, and initial finishing for polished concrete.
  - 4. Section 07 92 00 "Joint Sealants" for sealants installed with polished concrete flooring.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to polished concrete finishing including, but not limited to, the following:
    - a. Inspect and discuss condition of substrate and other preparatory work including concrete repair procedures.
    - b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, and equipment.
    - c. Review special designs and patterns.
    - d. Review protection of polished concrete.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Polishing Schedule: Submit plan showing polished concrete surfaces and schedule of polishing operations for each area of polished concrete before start of polishing operations. Include locations of all joints, including construction joints.

1.04 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for liquid floor treatments, indicating VOC content.
- B. Qualification Data: For Installer.

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1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A company experienced in performing specified work similar in design, products, and extent to scope of this Project; with a record of successful in-service performance; and with sufficient production capability, facilities, and personnel to produce specified work.
- B. Mockups: Before casting concrete, build mockups to demonstrate typical joints, surface finish, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
  - 1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
  - 2. Demonstrate curing, finishing, and protecting of polished concrete.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Liquid Floor Treatments:
    - a. VOC content limits for field applications.

2.02 PERFORMANCE REQUIREMENTS

- A. Coefficient of Friction: Provide polished concrete with the following values as determined by testing identical products:
  - 1. Level Surfaces Not Subject to Wetting: SCOF of not less than 0.50 in accordance with ANSI A1264.2 Section E11.2.
  - 2. Level Surfaces Subject to Wetting: DCOF of not less than 0.42 in accordance with ANSI A137.1.

2.03 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Advanced Floor Products; RetroPlate System.
  - 2. Diamatic USA; ULTRA-FLOR System.
  - 3. HTC LLC; Superfloor System.
  - 4. Husqvarna Construction Products; Hiperfloor System.
  - 5. The Bomanite Company; Bomanite Custom Polishing System.
  - 6. W.R. Meadows; Induroshine System.



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2.04 MATERIALS

- A. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.

PART 3 - EXECUTION

3.01 APPLICATION, GENERAL

- A. Place, rough grind, fine grind, and finish according to manufacturer's written instructions.
- B. Ensure that fluids from grinding operations do not stain floor by reacting with divider strips.

3.02 POLISHING

- A. Apply polished concrete finish system to cured and prepared slabs.
  - 1. Machine grind floor surfaces to receive polished finishes level and smooth.
  - 2. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
  - 3. Continue polishing with progressively finer-grit diamond polishing pads to gloss level, to match approved mockup.
  - 4. Control and dispose of waste products produced by grinding and polishing operations.
  - 5. Neutralize and clean polished floor surfaces.
- B. Aggregate Exposure Class: In accordance with ASCC's Concrete Polishing Council, based on visual observation of the overall area of the polished floor as follows:
  - 1. Class A, Cement Fines: Surface exposure of 85 to 95 percent cement fines and 5 to 15 percent fine aggregate.
- C. Polished Concrete Appearance Level: In accordance with ASCC's Concrete Polishing Council, with haze index less than 10 in accordance with ASTM D4039, and as follows:
  - 1. Level 1, Flat (Ground):
    - a. Distinctness-of-Image Gloss; ASTM D5767: Less than 9 percent.
    - b. Procedure: Not less than 4 step process with full refinement of each resin-bonded diamond pad with one application of densifier.
    - c. Grit Range: 100 or less.

3.03 CLEANING AND PROTECTION

- A. Cleaning:
  - 1. Remove grinding dust from installation and adjacent areas.

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2. Wash surfaces with cleaner according to manufacturer's written instructions; rinse surfaces with water and allow them to dry thoroughly.
- B. Protection: Provide final protection and maintain conditions that ensure that polished concrete floor is without damage or deterioration at time of Substantial Completion.

END OF SECTION



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SECTION 03 48 00 - PRECAST CONCRETE SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Stair treads and risers.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. For precast concrete units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details for precast concrete units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.

1.03 QUALITY ASSURANCE

- A. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Precast Concrete Products."

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery of precast concrete to avoid delaying the Work.
- B. Pack, handle, and ship precast concrete units in suitable packs or pallets.
  - 1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move precast concrete units if required, using dollies with wood supports.
  - 2. Store precast concrete units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations for Precast concrete: Obtain precast concrete units from single source from single manufacturer.



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2.02 PRECAST CONCRETE MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C114. Provide natural color or white cement as required to produce precast concrete color indicated.
- B. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C33/C33M; gradation and colors as needed to produce required precast concrete textures and colors.
- C. Fine Aggregates: Natural sand or crushed stone complying with ASTM C33/C33M, gradation and colors as needed to produce required precast concrete textures and colors.

2.03 FABRICATION

- A. Reinforce precast concrete units to resist handling, transportation, and erection stresses and specified in-place loads.
- B. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- C. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.
- D. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 117.
- E. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
- F. Discard and replace precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance.

2.04 PRECAST CONCRETE UNITS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Empire Precast.
  - 2. Wausau Tile, Inc.

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3. QCP Corp.
- B. Precast Concrete Units:
1. Units are manufactured using the manufacturer's selected method.
  2. Stair Treads and Risers: Sizes and configurations as indicated on Drawings.
- C. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.
- D. Fabrication Tolerances:
1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.
  2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.
  3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.
  4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.
- E. Exposed faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform, straight, and sharp. Finish exposed-face surfaces of precast concrete units as follows:
1. As-Cast Surface Finish: Provide surfaces to match approved sample for acceptable surface, air voids, sand streaks, and honeycomb.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION TOLERANCES

- A. Variation from Plumb: Do not exceed 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2 inch maximum.
- B. Variation from Level: Do not exceed 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2 inch maximum.
- C. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.

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- D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except where variation is due to warpage of units within tolerances specified.

3.03 ADJUSTING AND CLEANING

- A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Precast concrete may be repaired if methods and results are approved by Architect.
- B. Replace units in a manner that results in precast concrete matching approved Samples, complying with other requirements, and showing no evidence of replacement.

END OF SECTION



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SECTION 04 22 00 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Concrete masonry units.
  - 2. Mortar and grout.
  - 3. Steel reinforcing bars.
  - 4. Miscellaneous masonry accessories.
- B. Related Sections:
  - 1. Division 03 Section "Cast-In-Place Concrete".

1.02 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.03 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
  - 1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
  - 2. Mortar Test (Property Specification): For each mix required, according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and -ASTM C 91 for air content.
  - 3. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.
  - 4. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
  - 1. "Product Certificates for Credit MR 5" Subparagraph below applies to LEED-NC, LEED-CS, and LEED for Schools.
  - 2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or



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recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

- C. Shop Drawings: For the following:
  - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
  - 2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Material Certificates: For each type and size of the following:
  - 1. Masonry units.
    - a. Include material test reports substantiating compliance with requirements.
  - 2. Cementitious materials. Include brand, type, and name of manufacturer.
  - 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
  - 4. Grout mixes. Include description of type and proportions of ingredients.
  - 5. Reinforcing bars.
- C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
  - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
  - 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- D. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.06 QUALITY ASSURANCE

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.
- C. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.



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- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Administrative Requirements."

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Always retain first paragraph below in case Contractor uses a preblended, dry mortar mix.
- E. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.
- F. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.08 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
  2. Protect sills, ledges, and projections from mortar droppings.
  3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
  4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.



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- D. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
  - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40° F and higher and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

## PART 2 - PRODUCTS

### 2.01 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

### 2.02 CONCRETE MASONRY UNITS

- A. Regional Materials: CMUs shall be manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
  - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
  - 2. Provide square-edged units for outside corners unless otherwise indicated.
- C. Concrete Unit Masonry: Conforming to ASTM C90, hollow load-bearing concrete unit masonry.
  - 1. Density Classification: Medium weight unless otherwise indicated.
  - 2. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
  - 3. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

### 2.03 MORTAR AND GROUT MATERIALS

- A. Regional Materials: Aggregate for mortar and grout, cement, and lime shall be extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.



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- C. Hydrated Lime: ASTM C 207, Type S.
- D. Portland Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.
- E. Aggregate for Mortar: ASTM C 144.
- F. Aggregate for Grout: ASTM C 404.
- G. Water: Potable.

2.04 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M, Grade 60, or ASTM A 706/A 706M, Grade 60.

2.05 MISCELLANEOUS ANCHORS

- A. Anchor Bolts: Headed steel bolts complying with ASTM F 1544, Grade 36; with ASTM A 563, Grade A hex nuts and; ASTM F 436 flat washers, UNO drawings.

2.06 MISCELLANEOUS MASONRY ACCESSORIES

- A. Preformed Control-Joint Gaskets: Made from PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- B. Elastomeric Sealant: ASTM C 920, chemically curing polysulfide sealant; of type, grade, class, and use classifications required to seal joints and remain watertight.
- C. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

2.07 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
  - 1. Do not use calcium chloride in mortar or grout.
  - 2. Use portland cement-lime mortar unless otherwise indicated.
  - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.



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- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification for Type S.
- D. Grout for Unit Masonry: Comply with ASTM C 476.
  - 1. Use grout that will comply with Table 1.16.1 in ACI 530/ASCE 5/TMS 402 for dimensions of grout spaces and pour height.
  - 2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
  - 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
  - 2. Verify that foundations are within tolerances specified.
  - 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION, GENERAL

- A. Build chases and recesses to accommodate items specified in this and other Sections.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

#### 3.03 TOLERANCES

- A. Dimensions and Locations of Elements:



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1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

3.04 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.



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- C. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.
- D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- E. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- F. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
  - 1. Install compressible filler in joint between top of partition and underside of structure above.
  - 2. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section "Firestopping."

3.05 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
  - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
  - 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
  - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- C. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.06 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry as follows:
  - 1. Install preformed control-joint gaskets designed to fit standard sash block.
  - 2. Keep head joints free and clear of mortar or rake out joint for application of sealant.

3.07 FLASHING

- A. General: Install embedded flashing in masonry at lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.



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- B. Install flashing as follows unless otherwise indicated:
1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
  2. At lintels, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
  3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches (38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
  4. Install metal drip edges with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
  5. Retain one of three subparagraphs below if flexible flashing materials are used. See Evaluations.
  6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal drip edge.
- C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

3.08 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
  2. Limit height of vertical grout pours to not more than 60 inches.



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3.09 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.
- B. Inspections: Special inspections in accordance with Level 2 in TMS 402.
  - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
  - 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
  - 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- D. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.
- E. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.
- F. Non-destructive testing of in-situ construction per CBC2105A.4, exception 1 as indicated on drawings.

3.010 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
  - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
  - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.



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3. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.011 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Excess Masonry Waste: Remove excess clean masonry waste and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION



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SECTION 04 43 13.16 - ADHERED STONE MASONRY VENEER

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Stone masonry adhered to wood framing and sheathing.

1.02 ACTION SUBMITTALS

- A. Product Data: For each variety of stone, stone accessory, and manufactured product.
- B. Samples for Verification:
  - 1. For each stone type indicated. Include at least three Samples in each set, and show the full range of color and other visual characteristics in completed Work.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Material Test Reports:
  - 1. Stone Test Reports: For stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous five years.
  - 2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer, indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs experienced stonemasons and stone fitters.

1.05 PRECONSTRUCTION TESTING

- A. Preconstruction Sealant Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for compatibility and adhesion testing according to sealant manufacturer's standard testing methods and Section 07 92 00 "Joint Sealants," Samples of materials that will contact or affect joint sealants.

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1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- C. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, in a dry location, or in covered weatherproof dispensing silos.

1.07 FIELD CONDITIONS

- A. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.
  - 1. Extend cover a minimum of 24 inches down both sides, and hold cover securely in place.
- B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining stone masonry face.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
  - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1.08 COORDINATION

- A. Advise installers of other work about specific requirements for placement of flashing and similar items to be built into stone masonry.

1.09 WARRANTY

- A. Materials Warranty: Manufacturer agrees to repair or replace mortar bed, waterproofing, adhesives, mortars, and other installation materials that fail within specified warranty period.
  - 1. Warranty Period: 15 years from date of Substantial Completion.

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PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations for Stone: Obtain stone, from single quarry with resources to provide materials of consistent quality in appearance and physical properties.
- B. Source Limitations for Mortar and Waterproofing Materials: Obtain waterproofing materials, mortar ingredients of uniform quality for each cementitious component from single manufacturer, and each aggregate from single source or producer.

2.02 PERFORMANCE REQUIREMENTS

- A. General Performance: Adhered stone masonry veneer wall assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.03 GRANITE

- A. Material Standard: Comply with ASTM C615/C615M.
- B. Varieties and Sources: Subject to compliance with requirements, provide the following:
  - 1. Buechel Stone Corp.; LedgeStone, Earth Wood Tailored.

2.04 MATERIALS

- A. Metal Lath: ASTM C847; Galvanized, diamond metal lath; flat expanded type, weighing not less than 3.4 lb/sq. yd. (1.8 kg/sq. m) with factory applied paper backing.
  - 1. Paper Backing: Vapor-permeable paper, factory bonded to back of lath; complying with requirements in FS UU-B-790a for Type I, Grade D and with 60-minute water resistance.
- B. Waterproof Membrane, Fabric-Reinforced Fluid-Applied: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Laticrete International, Inc.; MVIS Air & Water Barrier, or comparable product by one of the following:
    - a. MAPEI Corporation.
    - b. Custom Building Products.

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- c. TEC; a subsidiary of H. B. Fuller Company.
  - C. Latex Portland Cement Mortar: For scratch coat: Weather, frost, shock resistant; formulated for exterior use with stone masonry veneer.
    - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Laticrete International, Inc.; MVIS Premium Mortar Bed, or comparable product by one of the following:
      - a. MAPEI Corporation.
      - b. Custom Building Products.
      - c. TEC; a subsidiary of H. B. Fuller Company.
  - D. Latex-Portland Cement Mortar (Thin Set): Product meeting requirements of ANSI A118.15 and specifically formulated for exterior use with stone masonry veneer.
    - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Laticrete International, Inc.; MVIS Hi-Bond Veneer Mortar, or comparable product by one of the following:
      - a. MAPEI Corporation.
      - b. Custom Building Products.
      - c. TEC; a subsidiary of H. B. Fuller Company.
  - E. Latex Portland Cement Pointing Mortar: Weather, frost, shock resistant; formulated for exterior use with stone veneer masonry.
    - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Laticrete International, Inc.; MVIS Pointing Mortar, or comparable product by one of the following:
      - a. MAPEI Corporation.
      - b. Custom Building Products.
      - c. TEC; a subsidiary of H. B. Fuller Company.
  - F. Flashing and Trim: In accordance with Section 07 60 00 - Flashing and Sheet Metal.
- 2.05 MASONRY CLEANERS
- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.
- 2.06 FABRICATION
- A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated.
    - 1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
  - B. Cut stone to produce pieces of thickness, size, and shape indicated, including details on Drawings and pattern specified in "Setting Stone Masonry" Article.

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- C. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated. Shape beds to fit supports.
- D. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.
  - 1. Clean sawed backs of stone to remove rust stains and iron particles.

2.07 MORTAR MIXES

- A. Mix mortars and grouts to comply with referenced standards and mortar manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone masonry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.03 SETTING STONE MASONRY

- A. Perform necessary field cutting and trimming as stone is set.
- B. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
- C. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.

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- D. Set stone to comply with requirements indicated on Drawings. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place. Set stone accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.
- E. Install embedded flashing at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

3.04 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.
- B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.
- C. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet or 3/4 inch in 40 feet or more.
- D. Measure variation from level, plumb, and position shown in plan as a variation of the average plane of each stone face from level, plumb, or dimensioned plane.
- E. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.
- F. Variation in Plane between Adjacent Stones: Do not exceed one-half of tolerance specified for thickness of stone.

3.05 INSTALLATION OF ADHERED STONE MASONRY VENEER

- A. Install flashing over sheathing and behind weather barrier by fastening through sheathing into framing.
- B. Install lath over weather barrier by fastening through sheathing into framing to comply with ASTM C1063.
- C. Install scratch coat over metal lath 3/8 inch thick to comply with ASTM C926.
- D. Install waterproofing membrane to comply with manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

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- E. Install masonry veneer in compliance with mortar manufacturer's written instructions. Work masonry veneer adhesive mortar into good contact with back of veneer unit making sure the entire unit is buttered to a nominal 1/2-inch thickness. Work buttered units into scratch coat.

3.06 ADJUSTING AND CLEANING

- A. Remove and replace stone masonry of the following description:
1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
  2. Defective joints.
  3. Stone masonry not matching approved samples and mockups.
  4. Stone masonry not complying with other requirements indicated.
- B. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.
- C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
  2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before cleaning stone masonry.
  3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
  4. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
  5. Clean stone masonry with proprietary acidic cleaner applied according to manufacturer's written instructions.

END OF SECTION



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SECTION 05 12 00 – STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to, the County's administrative requirements.
  - 2. Structural steel
  - 3. Grout
- B. Related Sections include the following:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to the County's administrative requirements.
  - 2. 01 40 00 Quality Requirements
  - 3. 05 50 00 Metal Fabrications
  - 4. 01 81 13.71 Sustainable Design Requirements

1.03 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
  - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
  - 2. Include embedment drawings.
  - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
  - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.



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- C. Weld Procedures: Submit weld procedures for connections other than rigid frames. Weld procedures shall be qualified as described in AWS D1.5, Section 5.12 or 5.13 for self shielded FCAW, Weld procedures shall indicate joints details and tolerances, preheat and interpass temperature, post-heat treatment, single or multiple stringer passes, peening of stringer passes for groove welds except for the first and the last pass, electrode type and size, welding current, polarity and amperes and root treatment. The welding variables for each stringer pass shall be recorded and averaged, from these averages the weld heat input shall be calculated.
- D. Welder's Certificates: Field welders shall be Project certified in accordance with AWS D1.1-02. Shop welders shall be Project certified for FCAWS in accordance with AWS D1.1-02.
- E. Qualification Data: For Installer and fabricator.
- F. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
  - 1. Structural steel including chemical and physical properties.
  - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
  - 3. Direct-tension indicators.
  - 4. Tension-control, high-strength bolt-nut-washer assemblies.
  - 5. Shear stud connectors.
  - 6. Shop primers.
  - 7. Non-shrink grout.
- G. Source quality-control test reports.
- H. Charpy-V-Notch (CVN) Impact Test: Submit certified copies of Charpy-V-Notch (CVN) Impact Test by the manufacturer for applicable steel members and components.
  - 1. Charpy-V-Notch (CVN) Impact Test for Base Metal: Moment frame columns, girders and other structural steel which is to be complete joint penetration welded and subjected to Charpy-V-Notch impact test in accordance with ASTM E 23 and ASTM A 673.
- I. Exception: Rolled shapes listed under Groups 4 and 5 of Table 2, Page 1-8 of the 9th edition of the AISC Manual of Steel Construction shall have the Charpy-V-Notch test, as specified above, performed on flange material at the juncture of the web and flange, shown in Figure C-A3 1C in AISC Manual – 9th edition.
  - 1. Frequency (P) in accordance with ASTM A 673 and utilizing standard specimen sizes shown in Figure 6 of ASTM E 23. The absorbed energy in a CVN impact test shall not be less than that specified in Material Part 2 of this section.
  - 2. Sustainable Design Requirements submittal form, found in Section 01 81 13.71 Sustainable Design Requirements. Provide the following for all structural steel framing:
    - a. Recycled content
    - b. Regional materials (if applicable)



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1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural steel, including chemical and physical properties.
- E. Product Test Reports: For the following:
  - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
  - 2. Direct-tension indicators.
  - 3. Tension-control, high-strength bolt-nut-washer assemblies.
  - 4. Shear stud connectors.
  - 5. Shop primers.
  - 6. Non-shrink grout.
- F. Source quality-control reports.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category [ACSE][CSE].
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
- D. Comply with applicable provisions of the following specifications and documents:
  - 1. AISC 303.
  - 2. AISC 341 and AISC 341s1.



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3. AISC 358.
4. AISC 360.
5. RCSC "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
6. AWS D1.1/D1.1M.
7. AWS D1.8/D1.8M.

E. Preinstallation Conference: Conduct conference at Project site.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
1. Fasteners may be repackaged provided Owner's Testing Agency observes repackaging and seals containers.
  2. Clean and relubricate bolts and nuts that become dry or rusty before use.
  3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.08 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS



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2.01 STRUCTURAL-STEEL MATERIALS

- A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
  - 1. W-Shapes: 60 percent.
  - 2. Channels, Angles, M, S-Shapes: 60 percent.
  - 3. Plates and Bars: 25 percent.
  - 4. Cold-Formed Hollow Structural Sections: 25 percent.
  - 5. Steel Pipe: 25 percent.
  - 6. All Other Steel Materials: 25 percent.
- B. W-Shapes: ASTM A 992/A 992M.
- C. Channels, Angles, M-, S-Shapes: ASTM A 36/A 36M.
- D. Plates and Bars: UNO on plans, ASTM A 572/A 572M, Grade 50.
- E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade C, structural tubing.
- F. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
  - 1. Finish: Black (except where indicated to be galvanized).
- G. Welding Electrodes: Comply with AWS requirements.

2.02 BOLTS, CONNECTORS, AND ANCHORS

- H. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
  - 1. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.
- I. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish; where indicated on Drawings.
  - 1. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.



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- J. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.
1. Finish: Hot-dip or mechanically deposited zinc coating. All threaded components of the fastener assembly must be galvanized by the same process. Mixing high-strength bolts that are galvanized by one process with nuts that are galvanized by the other is not permitted.
  2. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with mechanically deposited zinc coating finish.
- K. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex or round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
1. Finish: Plain.
- L. Shear Connectors: ASTM A 108, Grades 1010 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- M. Headed Anchor Rods: ASTM F 1554, Grade 36, typical; ASTM F 1554, Grade 55, weldable, when used in SLRS; straight.
1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
  2. Plate Washers: ASTM A 36/A 36M carbon steel.
  3. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
  4. Finish: Plain.
- N. Threaded Rods: ASTM A 36/A 36M.
1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
  2. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
  3. Finish: Plain.
- O. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.
- P. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.
- Q. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.



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- R. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement along one or two axes.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product.
  2. Mating Surfaces: PTFE and PTFE.
  3. Coefficient of Friction: Not more than 0.06 at 2,000 psi bearing pressure.
  4. Design Bearing Pressure: Not greater than 2,000 psi (13.7 MPa).

2.03 PRIMER

- A. Primer: SSPC-Paint 25, Type II, iron oxide, zinc oxide, raw linseed oil, and alkyd.

2.04 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, non-metallic aggregate grout, non-corrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.05 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Load and Resistance Factor Design Specification for Structural Steel Buildings."
1. Camber structural-steel members where indicated.
  2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
  3. Mark and match-mark materials for field assembly.
  4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.



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- F. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
  2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
  3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.06 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened, pre-tensioned or slip critical as indicated.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

2.07 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  2. Surfaces to be field welded.
  3. Surfaces to be high-strength bolted with slip-critical connections.
  4. Surfaces to receive sprayed fire-resistive materials.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 2, "Hand Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.



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2.08 GALVANIZING

- D. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
  - 1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
  - 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.03 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Load and Resistance Factor Design Specification for Structural Steel Buildings."
- B. Base and Bearing Plates: Clean concrete bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
  - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
  - 2. Weld plate washers to top of base plate.
  - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
  - 4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to



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cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
  - 1. Level and plumb individual members of structure.
  - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- G. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

#### 3.04 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
  - 1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Load and Resistance Factor Design Specification for Structural Steel Buildings" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

#### 3.05 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified independent Testing Agency to inspect field welds and high-strength bolted connections and prepare test reports.
- B. Inspections: Verify and inspect structural steel Work as shown on Drawings.



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- C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
  - 1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
    - a. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
    - b. Ultrasonic Inspection: ASTM E 164.
    - c. Radiographic Inspection: ASTM E 94.
- E. SFRS Connections: Test and inspect SFRS connection elements as indicated in accordance to AISC 341, AWS D1.1/D1.1M and AWS D1.8/D1.8M.
- F. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:
  - 1. Perform bend tests if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
  - 2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.
- G. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.06 REPAIRS AND PROTECTION

- A. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel. Applicable to galvanized connections.
  - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
  - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- B. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.

END OF SECTION



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SECTION 05 12 13 - ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Architecturally exposed structural steel (AESS).
- B. Related Sections:
  - 1. Section 05 12 00 "Structural Steel Framing" for additional requirements that also apply to AESS.

1.02 DEFINITIONS

- A. Architecturally Exposed Structural Steel: Structural steel designated as "architecturally exposed structural steel" or "AESS" in the Contract Documents.

1.03 COORDINATION

- A. Coordinate application of shop primers with topcoats with Division 09 painting sections.

1.04 ACTION SUBMITTALS

- A. Shop Drawings: Show fabrication of AESS components.
  - 1. Identify AESS category for each steel member and connection, including transitions between AESS categories and between AESS and non-AESS.
  - 2. Indicate orientation of mill marks .
  - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain. Indicate grinding, finish, and profile of welds.
  - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections. Indicate orientation and location of bolt heads.
  - 5. Indicate weep holes for HSS.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU and is experienced in fabricating AESS similar to that indicated on this Project.

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- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program, is designated an AISC-Certified Erector, Category CSE, and is experienced in erecting AESS similar to that indicated on this Project.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or SSPC-QP 3.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Use special care in handling AESS to prevent twisting, warping, nicking, and other damage during fabrication, delivery, and erection. Store materials to permit easy access for inspection and identification. Keep AESS members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect AESS members and packaged materials from corrosion and deterioration.
  - 1. Do not store AESS materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.07 FIELD CONDITIONS

- A. Field Measurements: Where AESS is indicated to fit against other construction, verify actual dimensions by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with requirements of ANSI/AISC 303, Sections 1 through 9 and as modified in Section 10, "Architecturally Exposed Structural Steel."

2.02 FILLER

- A. Polyester filler intended for use in repairing dents in automobile bodies.

2.03 PRIMER

- A. Steel Primer: Comply with Division 09 painting Sections.

2.04 FABRICATION

- A. Shop fabricate and assemble AESS to the maximum extent possible. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.
  - 1. Use special care handling and fabricating AESS before and after shop painting to minimize damage to shop finish.

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- B. Category AESS 1: In addition to special care used to handle and fabricate AESS, employ the following fabrication techniques according to AISC 303, Section 10 and Table 10.1.
  - 1. Surface preparation to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 2. Sharp edges ground smooth.
  - 3. Continuous weld appearance.
  - 4. Standard structural bolts.
  - 5. Weld spatters removed.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
  - 1. Cut, drill, or punch holes perpendicular to steel surfaces.
  - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
  - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
- E. Erection marks, painted marks, and other marks are permitted on steel surfaces of completed structure.

2.05 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  - 1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding specified tolerances.
  - 2. Use weld sizes, fabrication sequence, and equipment that limit distortions to allowable tolerances.
  - 3. Provide continuous, sealed welds at angle to gusset-plate connections and similar locations where AESS is exposed to weather.

2.06 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:
  - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  - 2. Surfaces to be field welded.
  - 3. Surfaces to be high-strength bolted with slip-critical connections.

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- B. Surface Preparation: In accordance with Division 09 painting Sections.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify, with steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments, showing dimensions, locations, angles, and elevations.
- B. Examine AESS for twists, kinks, warping, gouges, and other imperfections before erecting.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep AESS secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
1. If possible, locate welded tabs for attaching temporary bracing and safety cabling where they will be concealed from view in the completed Work.

3.03 ERECTION

- A. Take special care during erection to avoid marking or distorting the AESS and to minimize damage to shop painting. Set AESS accurately in locations and to elevations indicated and according to ANSI/AISC 303 and ANSI/AISC 360.
1. Remove welded tabs that were used for attaching temporary bracing and safety cabling and that are exposed to view in the completed Work. Take care to avoid any blemishes, holes, or unsightly surfaces resulting from the use or removal of temporary elements.
  2. Grind tack welds smooth.
  3. Remove backing and runoff tabs, and grind welds smooth.
  4. Orient bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
  5. Remove erection bolts, fill holes with weld metal or filler, and grind or sand smooth to achieve surface quality approved by Architect.
  6. Fill weld access holes with weld metal or filler and grind, or sand smooth to achieve surface quality as approved by Architect.
  7. Conceal fabrication and erection markings from view in the completed structure.

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3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to inspect AESS as specified in Section 05 12 00 "Structural Steel Framing." The testing agency is not responsible for enforcing requirements relating to aesthetic effect.
- B. Architect will observe AESS in place to determine acceptability relating to aesthetic effect.

END OF SECTION

HMC Architects

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ARCHITECTURALLY EXPOSED  
STRUCTURAL STEEL FRAMING  
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SECTION 05 31 00 - STEEL DECKING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
  - 1. Roof deck.
  - 2. Composite floor deck.
- B. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
  - 2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
  - 3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings:
  - 1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.04 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product Certificates: For each type of steel deck.
- C. ICC-ES Evaluation Reports: For steel deck.



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1.05 QUALITY ASSURANCE

- A. AISI "North American Specifications for the Design of Cold-Formed Steel Structural Members" (S100).
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
- B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Required fire-resistive ratings are as indicated.
  - 2. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
- C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- D. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.02 ROOF DECK

- A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:



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1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating.
2. Deck Profile: As indicated.
3. Profile Depth: As indicated.
4. Design Uncoated-Steel Thickness: As indicated.
5. Span Condition: Triple span or more where possible.
6. Side Laps: Overlapped or interlocking seam at Contractor's option.

## 2.03 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Vent Tabs: Provide factory punched vents projecting upwards in interior low flutes approximately 6 inches on center and providing 1-1/2 percent open area.
- C. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- D. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0593-inch (0.91-mm) (16 gage) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- E. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0593-inch (0.91-mm) (16 gage) design uncoated thickness, of same material and finish as deck, and of profile indicated.
- F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0593-inch (0.91-mm) (16 gage) design uncoated thickness, of same material and finish as deck unless otherwise indicated.
- G. Galvanizing Repair Paint: ASTM A780/A780M.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.



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3.02 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Locate deck bundles to prevent overloading of supporting members.
- C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
  - 1. Warp deck permitted only where indicated.
- E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.03 ROOF-DECK INSTALLATION

- A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches (38 mm) long, and as follows:
  - 1. Weld Diameter: 5/8 inch minimal (1/2 inch effective).
  - 2. Weld Spacing: Space and locate welds as indicated.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 36 inches (914 mm), and as follows:
  - 1. Mechanically clinch or button punch.
  - 2. Fasten with a minimum of 1-1/2-inch- (38-mm-) long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches (38 mm), with end joints as follows:
  - 1. End Joints: Lapped 2 inches (51 mm) minimum or butted at Contractor's option.



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- D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
  - 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.05 PROTECTION

- A. Do not use deck units for storage or working platforms until permanently secured in position.
- B. Construction loads must not exceed carrying capacity of deck.
- C. Concrete must be placed with care, avoiding impacts by dropping or dumping. Runways must be planked if using buggies or wheelbarrows. Heavy concentrated loads of concrete or crew and uniform loads exceeding 20 psf must be investigated for shoring construction.
- D. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- E. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION



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SECTION 05 40 00 – COLD FORMED METAL FRAMING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Load-bearing cold-formed structural steel studs.
- B. Interior wall framing using Cold Formed Metal Framing at plumbing walls, wall openings and cabinet-supporting walls.
- C. Formed steel accessories.
- D. Related Sections:
  - 1. Section 07 21 00 "Building Insulation."
  - 2. Section 09 22 16 "Non-Structural Metal Framing."

1.02 REFERENCES

- A. AISI – American Iron and Steel Institute
  - 1. S100 – Design of Cold-Formed Steel Structural Members.
  - 2. S200 – Cold-Formed Steel Framing – General Provisions.
  - 3. S211 – Wall Stud Design.
  - 4. S212 – Header Design.
  - 5. S213 – Lateral Design.
- B. ASTM International
  - 1. A 1003- Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated.
  - 2. C 645 – Nonstructural Steel Framing Members.
  - 3. A653/A653M - Steel Sheet, Zinc-Coated (galvanized) or Zinc-Iron Alloy - Coated (Galvanized) by the Hot-Dip Process.
  - 4. C 754 – Installation of Steel Framing Members.
  - 5. C955 - Load-Bearing Steel Studs, Runners, and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
  - 6. C 1513 – Steel Tapping Screws for Cold-Formed Steel Framing Connections.
- C. AWS D1.3 – American Welding Society, Structural Welding Code, Sheet Steel.
- D. CBC California Building Code 2013, Chapter 22A.

1.03 SUBMITTALS

- A. Provide product data on standard framing members. Describe materials and finish, product criteria, limitations and properties.



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- B. Mill certificates: signed by the steel sheet producer indicating steel sheet complies with requirements.

1.04 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in steel studs framing and components with five years minimum experience.
- B. Welding: welders certified by AWS

PART 2 - PRODUCTS

2.01 FRAMING MATERIALS

- A. Studs: ASTM A1003, Structural Grade 50, Type H (ST50H), sheet steel, formed to "wide flange" shape or "C" shape, punched web, 16 gauge (0.056", SSMA designation 54) thick unless noted otherwise on drawings, 50 ksi steel unless noted otherwise on drawings, sizes required to conform to details and scheduled wall thicknesses, and as required for structural performance. Studs shall be rolled from new sheet steel and shall not be produced from re-rolled steel.
  - 1. Properties: As listed in manufacturer's standard tables for applicable grade of steel and sizes.
  - 2. Conform to AISI S100 and AISI S200.
  - 3. Coating: Zinc coated per ASTM A653, G60.
- B. Track: ASTM A1003, Structural Grade 50, Type H, sheet steel, channel shaped, deep leg, 16 gauge (0.056", SSMA designation 54) thick unless noted otherwise on drawings, 50 ksi steel unless noted otherwise on drawings, solid web, long leg at ceilings, profile to produce snug fit over adjacent components.
  - 1. Conform to S100 – Design of Cold-Formed Steel Structural Members
  - 2. Approved pre-fabricated slotted slip track for top of wall: CEMCO Slotted Track (CST) 16 gauge, ICC ESR-2012 or equal as approved in accordance with Division 01, General Requirements for substitutions.
  - 3. Provide stand-off washers for fasteners.
  - 4. Install in accordance with manufacturer's recommendations and fire rating requirements.
  - 5. Coating: Zinc coated per ASTM A653, G60 [prime painted].
- C. Slotted Fire Track: CEMCO FAS Track ASTM A1003, Structural Grade 33, Type H, cut steel channel shaped, deep leg, 16 gauge (0.056") thick unless noted otherwise on drawings, 33 ksi steel unless noted otherwise on drawings, solid web, long leg at ceilings, profile to produce snug fit over adjacent components. Track is designed with intumescent fire proofing on both sides of the track. Intumescent material to lap over the top of the track by 0.25" on each side of the track and down each leg 1.18" to an



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external groove. Slotted fire track shall be listed by UL Fire Resistance Directory as a firestop for the application used.

- D. Fire Strap: CEMCO FAS Strap ASTM A653, Grade 33 with a minimum 33 ksi yield strength to span between flutes of metal decking. Fire strap to have a minimum of a 1-inch wide continuous strip of intumescent running parallel and along each edge of the strap. Fire strap shall be listed by UL Fire Resistance Directory as a firestop for the application used.
- E. Header and Jambs: ClarkDietrich Building Systems, Heavy Duty Studs and Header Brackets.
  - 1. ProX Header, Brady Construction Innovations Inc. or equal where specified.
- F. Stiffener U- Channels and Angles: Minimum Weights as Follows:
  - 1. 3/4 inch - .3 pound per foot, cold- or hot-rolled channel.
  - 2. 1-1/2 inches - .475 pound per foot, cold-rolled channel.
  - 3. 1-1/2 inches - 1.12 pounds per foot, hot-rolled channel.
  - 4. 2 inches - 1.26 pounds per foot, hot-rolled channel.
  - 5. 2 inches - .59 pound per foot, cold-rolled channel.
  - 6. 1-1/2 x 1-1/2 x 3/16 inch angle.

## 2.02 ACCESSORIES

- A. Fastening: Self-drilling, Self-tapping Screws, ASTM C954, galvanized, Buildex/Tomarco Type S-12 point, low profile head screws #10 or equal, 1/2 inch long for two layers 16 gauge metal for non load-bearing framing, welded connections for load-bearing framing and for framing of 16 gauge studs and thicker.
  - 1. Welding: In conformance with AWS D1.3, minimum weld size 3/32.
- B. Anchorage Devices, Powder Actuated:
  - 1. Install to conform to the load requirements of this Section and Tables 1, 2, 3 and 4 of ICC-ESR 1663 Hilti. Minimum diameter: 0.145" diameter.
    - a. Utilize tools as recommended by the manufacture in compliance with ICC numbers.
    - b. ICC-ESR 1663 Hilti Inc., Fasteners – Manual, Pneumatic, or Powder-Driven Steel Studs and Nails.
  - 2. Allowable Loads: Limited 100 lbs. Maximum or 80% of ICC approved values. Testing required, refer to Division 01.
  - 3. Use of Powder actuated fasteners for tension loads is limited to support of minor loads such as suspended acoustical ceilings, ductwork and conduit. Permissible Loads for Ceiling Clip Assembly:
    - a. Normal-Weight Concrete: Ceiling Clip Assembly, minimum 0.177 inch diameter, minimum penetration 1-1/2 inch. Required Allowable Loads: 100 lbs. or 80 percent of values listed in ICC Report whichever is less: [ICC ES-2184](#).
      - 1) Type CC27ALH42 w/DX KWIK, by Hilti, Inc., Tulsa, OK



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- 2) Type CC27ALH42 w/DX KWIK, by Hilti, Inc., Tulsa, OK.
    - b. Lightweight Concrete: Ceiling Clip Assembly, minimum 0.177 inch diameter, minimum penetration 1-1/4 inch. Required Allowable Loads: 100 lbs. or 80 percent of values listed in ICC ES-2184:
      - 1) Type CC27ALH32, by Hilti, Inc., Tulsa, OK.
  - C. Anchorage Devices, Drilled Expansion Anchors:
    - 1. Wedge Type:
      - a. KWIK Bolt TZ Concrete Anchor, ICC ESR-1917, by Hilti Inc.
      - b. KWIK Bolt 3 CMU Anchor, ICC ES-1385, Hilti Kwik Bolt 3 (KB3).
    - 2. Adhesive Anchors System:
      - a. For normal weight concrete, ICC ESR-3814, Hilti HIT-RE 500-V3 Adhesive Anchor System.
      - b. For grouted CMU, ICC ESR-4143, Hilti HIT HY-270 Adhesive Anchor System.
  - D. Masonry Anchors: 1/4" diameter, Tapcon with Advance Threadform Technology, heat-treated steel, by Illinois Tool Works/Buildex, ICC-ESR-1671. Slotted Hex Washer Head.
  - E. Backings: Located and as indicated on drawings or 6" x 1-1/4" x 14 gauge flush mount backing, preformed with pre-punched screw holes, FLUSH-MOUNT BACKING by Metal-Lite, Inc., Anaheim, CA.
  - F. Track Bedding Sealant: Per Section 079200 "Joint Sealants.
  - G. Wall finishes: Per Division 09 Finishes.
- 2.03 FINISHES
- A. Galvanized Finish: Zinc coated per ASTM A653, G60.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Verify that substrate surfaces and building framing components are ready to receive work.
- B. Beginning of installation means acceptance of existing conditions.
- C. Layout markings shall not be made with xylene-based inks, paint, or dyes, or with other solvent-based products that may bleed through finishes.



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3.02 ERECTION OF STUDDING

- A. Perform work in accordance with, AISI and SSMA/ICC ES - 3064P.
- B. Align floor and ceiling tracks; locate to wall or partition layout. Secure in place with specified fasteners at spacing as indicated on drawings or maximum 32 inches on centers.
  - 1. Set floor track on continuous sealant, each side of track for exterior walls. Sealant type: Butyl Rubber per ASTM C920.
  - 2. Track Splices: notch flanges to allow sliding tracks past each another 12". Attach as approved by manufacturer of system.
- C. Place studs at 16 inches oc typically, or 12 inches oc in plumbing walls or as noted on drawings. Connect studs to tracks using fastener or welding method.
- D. No flame (oxyacetylene) torch cutting is permitted, use Plasma Arc cutting to make penetrations for conduit or piping where required.
- E. Construct corners using minimum three studs.
- F. Install double (boxed) studs at each head, jamb and sill of each exterior and interior door and window opening. Extend studs from floor to underside of structure above. Weld all boxed jamb and header members with interrupted 1/8" welds, one inch long at 12 inches on center.
- G. Install 1-1/2 inch standard steel furring channels at right angles to king stud at each door hinge point as permitted by perforations. Weld channel to four studs where possible.
- H. Stiffeners: Install 3/4 inch standard steel furring channel stiffeners within 24 inches of top and bottom runners and at mid height of walls eight feet high. At higher walls, install stiffeners spaced maximum 48 inches on centers. Weld stiffeners to each stud and at laps.
- I. In areas where a finish material occurs on one side of wall only, provide full width bridging or bracing. Two systems permitted:
  - 1. Install 3/4 inch x 16 gauge continuous brace through stud punch-outs, fastened to studs with angle clips welded or screw fastened, spaced as scheduled below.
  - 2. Install 1-1/4 inch x 16 gauge strap, 3/4 inch x 16 gauge or cold-rolled channel continuous across unrestrained edges of studs spaced as scheduled below, screw fastened or welded to each stud, and connected to one blocking member screw fastened or welded to adjacent studs.
- J. Bridging or Bracing Schedule:



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Stud Size AIS/SSMA on structural drawings	Min. bracing spacing unless noted otherwise
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3-5/8 or 4 in, S-Sections ("c")	2'-6"
3-5/8 or 4 in, T-Sections ("w")	3'-0"
6 in, S-Sections ("c")	2'-6"
6 in, T-Sections ("w")	3'-0"

- K. Erect studs one piece full length. Splicing of studs is not permitted, except where detailed.
1. Where studs have been cut to receive piping conduits and equipment, weld on two 3/4 inch furring channels to restore stability of weakened stud unless noted otherwise on the drawings.
- L. Erect studs, brace and reinforce full strength to meet design requirements.
- M. Extend stud framing through ceiling to underside of floor or roof structure above unless detailed otherwise.
- N. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
- O. Install intermediate studs above and below openings to match wall stud spacing.
- P. Provide deflection allowance of 1/2 inch minimum in stud track, directly below horizontal building framing for non-load bearing framing.
- Q. Provide deflection allowance of 1/2 inch minimum in stud track, directly below horizontal building framing for non-load bearing framing.
1. Where Casework is anchored as part of a larger wall or panel: Refer to Section 06 41 16.
- R. Install framing between studs for attachment of mechanical and electrical items and to prevent stud rotation.
- S. Touch-up field welds and damaged primed surfaces with primer.
- T. Erect 2 stud construction at expansion joints, 20 feet on center or as indicated on Drawings.



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3.03 CEILING JOIST FRAMING

- A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, punched with enlarged service holes, with stiffened flanges, and as follows:
  - 1. Minimum Base-Metal Thickness:
    - a. 20 GA (0.0329 inch).
    - b. 18 GA (0.0428 inch).
    - c. 16 GA (0.0538 inch).
    - d. 14 GA (0.0677 inch).
    - e. 12 GA (0.0966 inch).
  - 2. Flange Width: 1-5/8 inches Install per drawings and conform to SSMA., minimum unless noted otherwise on structural drawings.
  - 3. Install per drawings and conform to SSMA.

3.04 TOLERANCES

- A. Maximum Variation from True Position: 1/8 inch in 10 feet.
- B. Maximum Variation of any Member from Plane: 1/8 inch.

3.05 CLEANING

- A. Clean substrate; remove dirt, oil, grease, construction markings, and foreign matter that could adversely affect final floor finish appearance or performance.

3.06 QUALITY CONTROL

- A. Inspection of all field-welding operations shall be performed by qualified and certified Welding Inspector approved by the Structural Engineer and County.
- B. Welding Inspector shall check materials, equipment, procedures, welds and certification of welders. Furnish the Owner with reports verified by the Inspector that welding has been performed in accordance with the Contract documents.

END OF SECTION



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SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Miscellaneous metal items indicated and specified, or otherwise necessary for completion of the work. Work of this section includes, but is not limited to, the following:
  - 1. Ferrous and non-ferrous metalwork detailed on the drawings as a component part of other assemblies, but not specified elsewhere.
  - 2. Miscellaneous steel framing and supports including:
    - a. Operable partitions.
    - b. Mechanical and electrical equipment.
    - c. Applications where framing and supports are not specified in other Sections.
  - 3. Metal ladders.
  - 4. Metal bollards.
- B. Related Sections:
  - 1. Division 05 Section structural steel framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.

1.02 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.03 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Fasteners.
  - 2. Shop primers.
  - 3. Slotted channel framing.
  - 4. Manufactured metal ladders.
  - 5. Metal bollards.
- B. Shop Drawings: Show fabrication and installation details for metal fabrications.

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1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

- C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
  1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.05 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.06 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design metal fabrications, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
  1. Structural Performance, General: Design metal fabrications to withstand the effects of gravity loads within limits and under conditions indicated.
  2. Seismic Performance: Provide metal fabrications capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.
  3. Structural Performance of Slotted Channel Framing: Slotted Channel Framing shall withstand the effects of loads and stresses applied by equipment being supported.

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- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- D. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- E. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
  - 1. Manufacturers: Subject to compliance with requirements, acceptable manufacturers include, but are not limited to, the following:
    - a. Unistrut
  - 2. Size of Channels: 1-5/8 by 1-5/8 inches.
  - 3. Material: Cold-rolled steel, ASTM A1008/A1008M, commercial steel, Type Bor structural steel, Grade 33; 0.0528-inch minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel.

2.03 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.
- D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.

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1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

F. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

2.04 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Division 09 "Painting" Sections.

B. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.05 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

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- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.06 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
  - 1. Fabricate units from slotted channel framing where indicated.
  - 2. Furnish inserts for units installed after concrete is placed.
- C. Fabricate supports for operable partitions from continuous steel beams of sizes recommended by partition manufacturer with attached bearing plates, anchors, and braces as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.
- D. Galvanize miscellaneous exterior framing and supports.
- E. Prime miscellaneous framing and supports where indicated.

2.07 METAL LADDERS

- A. General:

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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. ACL Industries, Inc.
  - b. Alco-Lite Industrial Products.
  - c. Halliday Products.
  - d. O'Keeffe's Inc.
  - e. Precision Ladders, LLC.
  - f. Royalite Manufacturing, Inc.
  - g. Thompson Fabricating, LLC.
2. Comply with ANSI A14.3.
3. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails 18 inches apart unless otherwise indicated.
2. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
3. Galvanize exterior ladders, including brackets.

2.08 METAL BOLLARDS

A. Fixed Bollard:

1. Basis-of-Design Product: Reliance Foundry Co. Ltd.; R-8460-RA Powder Coated Bollard.
2. Design: Cylindrical with flat top.
3. Material:
  - a. Stainless Steel Pipe: ASTM A312, Grade TP 316.
  - b. Stainless Steel Plate: ASTM A959, Grade TP 316.
4. Finish: Manufacturer's standard powder coating.
  - a. Color: As selected by Architect from manufacturer's full range.

B. Removable Bollard: Removable bollard with elevated internal locking hardware.

1. Basis-of-Design Product: Reliance Foundry Co. Ltd.; R-8464-RA Powder Coated Removable Bollard.
2. Design: Cylindrical with flat top.
3. Material:
  - a. Stainless Steel Pipe: ASTM A312, Grade TP 316.
  - b. Stainless Steel Plate: ASTM A959, Grade TP 316.
4. Finish: Manufacturer's standard powder coating.
  - a. Color: As selected by Architect from manufacturer's full range.

2.09 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

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2.10 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.11 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
  - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
  - 1. Shop prime with universal shop primer unless zinc-rich primer is indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
  - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 3. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
  - 4. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
  - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

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- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.02 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for operable partitions securely to, and rigidly brace from, building structure.

3.03 INSTALLATION OF METAL BOLLARDS

- A. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- B. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.
- C. Place removable bollards over internal sleeves and secure . .



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3.04 REPAIRS

- A. Galvanized Surfaces: Clean field welds and damaged areas and repair galvanizing to comply with ASTM A 780/A 780M, in accordance with Annex A1 zinc solder or Annex A3 metallizing. Repair method in accordance with Annex A2 galvanizing repair paint not permitted.

END OF SECTION

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SECTION 05 70 00 - DECORATIVE METAL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Custom fabricated interior decorative metal items as indicated and as follows:
  - 1. Metal base.
- B. Related Sections:
  - 1. 05 5500 - Metal Fabrications: For non-decorative metal fabrications.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated, including finishing materials.
- B. Shop Drawings: Show fabrication and installation details for decorative metal.
  - 1. Include plans, elevations, component details, and attachments to other work.
  - 2. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
- C. Samples for Verification: For each type of exposed finish required.
  - 1. Sections of linear shapes.
  - 2. Samples of welded joints showing quality of workmanship.

1.03 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

1.04 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

1.05 COORDINATION

- A. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

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PART 2 - PRODUCTS

2.01 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. Provide materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.02 STAINLESS STEEL

- A. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304.

2.03 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:
  - 1. Stainless-Steel Items: Type 304 stainless-steel fasteners.
  - 2. Dissimilar Metals: Type 304 stainless-steel fasteners.
- B. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.

2.04 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.05 FABRICATION, GENERAL

- A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- B. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
- D. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

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- E. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- F. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.
- G. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.
- H. Comply with AWS for recommended practices in shop welding. Weld behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded joints of flux, and dress exposed and contact surfaces.
  - 1. Where welding cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 Welds: no evidence of a welded joint.

2.06 METAL BASE

- A. Custom Fabricated Metal Base: Form metal base from metal of type and thickness as follows, unless indicated otherwise.
  - 1. Material:
    - a. Stainless-Steel Sheet: 0.050 inch.
      - 1) Finish: No. 4.
  - 2. Form in lengths of not less than 12 feet.
  - 3. Corners: Welded with full-length, full-penetration welds. Use welding method that is appropriate for metal and finish indicated. Finish exposed welds and surfaces smooth, flush, and blended to match adjoining surfaces. Fabricate with 3 inch legs each side, unless indicated otherwise.
- B. Seams: Butt jointed and tightly fitted.

2.07 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.08 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

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- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
  - 1. Run grain of directional finishes with long dimension of each piece.
- C. Directional Satin Finish: No. 4.
- D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION, GENERAL

- A. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.
- B. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
- C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.
- D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
- E. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
  - 1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.



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- F. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

3.03 TOUCHUP AND PROTECTION

- A. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION



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SECTION 05 71 00 - DECORATIVE METAL STAIRS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Interior and exterior decorative steel-framed stairs.
- B. Related Sections:
  - 1. Section 03 48 00 "Precast Concrete Specialties" for precast concrete treads.
  - 2. Section 05 57 30 "Decorative Metal Railings" for decorative metal railings attached to decorative metal stairs.
  - 3. Section 09 91 00 "Painting" for primers and topcoats.

1.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Stairs: Decorative metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
  - 1. Uniform Load: 100 lbf/sq. ft..
  - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
  - 3. Uniform and concentrated loads need not be assumed to act concurrently.
  - 4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
  - 5. Limit deflection of treads, platforms, and framing members to L/360 .
- B. Seismic Performance: Decorative metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.03 SUBMITTALS

- A. Product Data: For decorative metal stair products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.

1.04 QUALITY ASSURANCE

- A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

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1. Decorative Stairs: Architectural class.

- B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.05 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for decorative metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

PART 2 - PRODUCTS

2.01 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.  
1. Provide galvanized finish for exterior installations and where indicated.
- D. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25, unless another grade is required by design loads; exposed.
- E. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, either commercial steel, Type B, or structural steel, Grade 33, unless another grade is required by design loads.

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2.02 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

2.03 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Division 09 Section "Painting."
- C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.04 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
  - 1. Join components by welding unless otherwise indicated.
  - 2. Use connections that maintain structural value of joined pieces.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld connections to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Weld exposed corners and seams continuously unless otherwise indicated.



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5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.

- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

1. Fabricate joints that will be exposed to weather in a manner to exclude water.
2. Provide weep holes where water may accumulate internally.

## 2.05 STEEL-FRAMED STAIRS

- A. Stair Framing: As indicated on Drawings.

## 2.06 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish decorative metal stairs after assembly.
- C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
  1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
  2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces using methods recommended in writing by coating manufacturer, but not less than the following: SSPC-SP 3, "Power Tool Cleaning."
- E. Apply shop primer to uncoated surfaces of metal stair components, except those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting.

## PART 3 - EXECUTION

### 3.01 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing decorative metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

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- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing decorative metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install decorative metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
- F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.
- G. Install precast concrete treads with adhesive supplied by manufacturer.

3.02 INSTALLING DECORATIVE METAL STAIRS WITH GROUTED BASEPLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.
- B. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
  - 1. Use nonmetallic, nonshrink grout unless otherwise indicated.
  - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.03 ADJUSTING AND CLEANING

- A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.
- B. Galvanized Surfaces: Clean field welds and damaged areas and repair galvanizing to comply with ASTM A 780/A 780M, in accordance with Annex A1 zinc solder or Annex A3 metallizing. Repair method in accordance with Annex A2 galvanizing repair paint not permitted.

END OF SECTION



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SECTION 06 10 00 – ROUGH CARPENTRY

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included: Provide and install wood framing, sheathing, furring and other rough carpentry as indicated on the Drawings, specified herein, and as needed for a complete and proper installation.
- B. Related Work:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to, the County's administrative requirements.
  - 2. 06 40 00 Architectural Wood Casework.

1.02 REFERENCES

- A. ASME B18.2.1 - Square and Hex Bolts and Screws.
- B. APA (The Engineered Wood Association) - Engineered Wood Construction Guide.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- D. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- E. ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- F. AWPA C2 - Lumber, Timbers, Bridge Ties and Mine Ties-Preservative Treatment by Pressure Processes.
- G. AWPA C31 - Lumber Used Out Of Contact with the Ground and Continuously Protected from Liquid Water-Treatment by Pressure Processes.
- H. C.B.C. (California Building Code) 2013 Edition.
- I. FS UU-B-790 - Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent, and Fire Resistant).
- J. Redwood Inspection Service - Standard Specifications for Grades of California Redwood Lumber.
- K. WCLIB - West Coast Lumber Inspection Bureau.



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- L. WWPA (Western Wood Products Association) - Western Lumber Product Use Manual.

1.03 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Codes and Standards: In addition to complying with pertinent codes and regulations of governmental agencies having jurisdiction, unless otherwise specifically directed or permitted by the Architect comply with the following.
  - 1. "Western Lumber Product Use Manual" of the WWPA for selection and use of products included in that manual.
  - 2. "Engineered Wood Construction Guide" of the APA.
  - 3. "Standard Specifications for Grades of California Redwood Lumber" of the Redwood Inspection Service, when Redwood is used.

1.04 PRODUCT HANDLING

- A. Comply with pertinent provisions of the County's administrative requirements.
- B. Protection: Carefully pile lumber off the ground. Cover all materials and protect from weather.

PART 2 - PRODUCTS

2.01 GRADE STAMPS

- A. Identify framing lumber by the grade stamp of the WCLIB, or such other grade stamp as is approved in advance by the Architect.
- B. Identify plywood as to species, grade, and glue type by the stamp of the APA.

2.02 MATERIALS

- A. Provide materials in the quantities needed for the Work shown on the Drawings, and meeting or exceeding the following standards of quality:
  - 1. Minimum Lumber Grades (with structural grades noted on Structural Drawings):
    - a. 2 x Studs Douglas Fir #1
    - b. 2 x Studs in walls taller than or equal to 12'-0" Douglas Fir #1
    - c. 2 x and deeper Douglas Fir #1
    - d. 4 x in non-load bearing walls Douglas Fir#1
    - e. All other 4 x Beams Douglas Fir#1
    - f. 4 x Posts Douglas Fir#1



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- g. All 6 x and larger Douglas Fir #1
- h. All furring Douglas Fir Standard Grade
- 2. All Sill Plates Bearing on Concrete or Masonry: Pressure treated Douglas Fir.
- 3. Plywood: Standard sheathing with exterior glue. PS 1-95 with factory grading mark, as noted on Drawings.
- 4. Wood Preservative:
  - a. Preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium.
  - b. No materials to contain added urea-formaldehyde.
  - c. Preservative Treatment by Pressure Process: AWP A U1, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWP A C31 with inorganic boron (SBX).
- 5. Rough Hardware:
  - a. Steel Items:
    - 1) Comply with ASTM A36
    - 2) Use galvanized at exterior locations.
  - b. Machine Bolts: Comply with ASTM A307.
  - c. Lag Bolts: Comply with ASME B18.2.1.
  - d. Nails:
    - 1) Use common except as otherwise noted.
    - 2) Comply with ASTM F1667.
    - 3) Use galvanized at exterior locations.
- 6. Building Paper: Kraft paper complying with FS UU-B-790.

## 2.03 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

## PART 3 - PART 3 – EXECUTION

### 3.01 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

### 3.02 WORKMANSHIP

- A. Carefully lay out, fit, and erect all framing plumb and level.
- B. Produce joints which are tight, true, and well nailed, with members assembled in accordance with the Drawings and with pertinent codes and regulations.



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3.03 GENERAL FRAMING

A. General:

1. In addition to framing operations normal to the fabrication and erection indicated on the Drawings, install all wood blocking, backing, and framing required for the work of other trades.
2. Bearing studs may be notched to a depth not exceeding 1/4 its width but no closer than 5/8" to the edge of the stud.
3. Non-bearing studs may be notched to a depth not exceeding 40% of its width of bored to 60% of its width but not closer than 5/8" to the edge of the stud.

B. Bracing:

1. Brace all walls not solidly sheathed with 1 x 6 diagonal bracing at each end and at 25 feet on center per CBC.
2. Adequately brace structure as erection progresses.

3.04 BLOCKING

A. Install blocking as required to support items of finish and to cut off concealed draft openings, both vertical and horizontal, between all ceiling and floor area.

B. Install solid blocking between joists at points of support and wherever sheathing is discontinuous. Blocking may be omitted where joists are supported on metal hangers.

3.05 ALIGNMENT

A. On framing members to receive a finished surface, align the finish subsurface to vary not more than 1/8" from the plane of surfaces of adjacent furring and framing members.

3.06 INSTALLATION OF PLYWOOD SHEATHING

A. Placement: Place plywood with face grain perpendicular to supports and continuously over at least two supports, except where otherwise shown on the Drawings.

3.07 FASTING

A. Nailing:

1. Use only Common wire nails or spikes of the dimension shown on the Wailing Scheule, except where otherwise specifically noted on the Drawings.
2. Use untreated steel nails for interior work and concealed framing, and galvanized nails for all exposed exterior work.
3. Use nails long enough to penetrate at least one-half thickness of material.
4. Remove split members and replace with members complying with the specified requirements.

B. Bolts and Screws:



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1. Drill holes 1/16" larger in diameter than the bolts being used.
2. Drill straight and true from one side only.
3. For lag screws and wood screws, pre-bore holes same diameter as root of threads, enlarging holes to shank diameter for length of shank.
4. Screw, do not drive, lag screws and wood screws.

3.08 NAILING SCHEDULE

- A. Unless otherwise directed by the Architect, comply with the nailing schedule and other fastening requirements contained in the pertinent regulations of governmental agencies having jurisdiction.

3.09 CLEANUP

- A. Broom clean inside and out, removing from the site all scraps and other debris left or caused by this work.

END OF SECTION



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SECTION 06 16 43 - GYPSUM SHEATHING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Exterior wall, parapet, and soffit gypsum sheathing.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.01 GYPSUM SHEATHING

- A. Gypsum Wall and Soffit Sheathing: Provide one of the following:
  - 1. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M, Type X, 5/8 inch thick.
    - a. Product: Subject to compliance with requirements, provide one of the following:
      - 1) CertainTeed Corp.; GlasRoc Sheathing.
      - 2) Georgia-Pacific Gypsum LLC; Dens-Glass Gold.
      - 3) USG Corporation; Securock Glass Mat Sheathing.

2.02 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
  - 1. For gypsum sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117.
- B. Screws for Fastening Gypsum Sheathing to Wood Framing: ASTM C1002.



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PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.
- C. Coordinate sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- D. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

3.02 GYPSUM SHEATHING INSTALLATION

- A. Comply with ASTM C1280 and with manufacturer's written instructions.
  - 1. Fasten gypsum sheathing to wood framing with screws.
  - 2. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
  - 3. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing, in compliance with ASTM C954.
- C. Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
  - 1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.

END OF SECTION



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SECTION 06 17 33 – WOOD I JOISTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Prefabricated plywood web joists.
- B. Related Sections:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to, the County's administrative requirements.
  - 2. 01 40 00 Quality Requirements
  - 3. 06 10 00 Rough Carpentry.

1.02 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings indicating joist locations, sizes, camber, spacing, species, stress grades and attachment details.
- B. Evaluation Reports: Submit research or evaluation reports stating compliance to CBC.

1.03 QUALITY ASSURANCE

- A. Comply with the following as a minimum requirement: Prefabricated plywood web joists shall comply with requirements of ICC Evaluation Service, Inc. report No. PFC-5803, current editions.
- B. Fabrication and installation of wood chord metal joists shall comply with requirements of CBC Chapter 23.
- C. Provide special inspections per CBC Chapter 17.
- D. Each member shall be stamped with an identifying mark. Manufacturer shall provide a verified report identifying members by mark and including pertinent data such as certification of flange material and species, type of glue, and other information as may be required.
- E. Plywood web joist fabrication shall be inspected as part of manufacturer's approved quality assurance program. Inspection shall be performed in accordance with Section 01 40 00 – Quality Requirements.
- F. Store plywood web joists above grade on platforms, skids, or other required supports.
- G. Protect joists from moisture with polyethylene film or waterproof paper.



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PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURES

- A. TrustJoist, A Weyerhaeuser Business.
- B. Standard Structures, Inc.
- C. Louisiana-Pacific Corporation.
- D. Georgia-Pacific Corporation.
- E. Equal.

2.02 MATERIALS

- A. Wood Chord: Solid-sawn lumber, laminated veneer lumber (LVL), laminated strand lumber (LSL) or machine-stress-rated (MSR) structural lumber. Allowable unit stresses for chord members shall be as set forth in applicable California Building Code and as noted in the ICC reports. Lumber grade identification shall be as indicated on Drawings.
- B. Web shall be plywood or oriented strand board.
- C. Accessories: Supply miscellaneous accessories including bracing, blocking, stiffeners, bearing clips, and any other required accessories required by joist manufacturer to complete joist installation.
- D. Adhesives: Adhesives must meet requirements for exterior type complying with ASTM D2559.

2.03 FABRICATIONS

- A. Fabrication joist in accordance with referenced standards.
- B. TJI Joists: Plywood web type members, structural grade plywood Micro-Lam or machine stress rated lumber chord flanges assembled with waterproof glues; plywood webs of APA Structural 1 Grade installed with face grain running in vertical direction of members and butt jointed for a continuous web member; web pressure formed and tightly fitted into a groove routed on centerline of wide face of flange members to form a pressure glue joint at that junction.
  - 1. Flanges: Joist shall be factory fabricated with micro-lam billets utilizing waterproof glues and having machine stress rating of  $F_b=2,100$  psi,  $E=1,800,000$  psi. Moisture content at time of fabrication shall be between 7 and 19 percent of a surface dry basis. Joist shall be pre-qualified, finger joints.



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2. Webs: Plywood complying with PS 1, C-C Structural 1, grade marked by an ICC-approved agency or oriented strand board OSB complying with APA E446. Moisture content at time of fabrication shall be between 7 to 16 percent. Difference in average moisture content between panels glued to core gaps at ends shall not be furnished. Install plywood web with face veneers oriented vertically, and butt jointed with adhesive to form a continuous member. Top and bottom edges of webs shall be specially prepared and pressure fitted into a machined groove in center of wide face of flange members so as to form a tight glued junction. Provide web bearing stiffeners as indicated.
3. Adhesives: Exterior type, phenol, resorcinol or phenol-resorcinol. Adhesive shall be mixed and handled in accordance with manufacturer's instructions.

PART 3 - EXECUTION

3.01 GENERAL

- A. Joists shall be of sizes and spacing indicated. Top and bottom chord and web members shall be of sizes and stress-grade lumber indicated or specified.

3.02 INSTALLATION

- A. Joints shall be installed in accordance with Drawings and Shop Drawings.
- B. Temporary construction loads, which cause stresses beyond design limits, shall not be applied to joists.
- C. Installation bracing, in addition to specified bridging, bracing shall be provided as required to keep joists straight and plumb until sheathing material has been installed.

3.03 PROTECTION

- A. Protect Work of this section until Substantial Completion.

END OF SECTION



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SECTION 06 41 00 - ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Plastic-laminate-clad cabinets.
  - 2. Cabinet hardware and accessories.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For architectural cabinets.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Show large-scale details.
  - 3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
  - 4. Show locations and sizes of cutouts and holes for items installed in architectural cabinets.
- C. Samples for Verification: For the following:
  - 1. Thermally Fused Laminate (TFL) Panels: 8 by 10 inches, for each color, pattern, and surface finish.
    - a. Provide edge banding on one edge.
  - 2. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.04 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for composite wood products, indicating compliance with emissions testing or certification.

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1.05 QUALITY ASSURANCE

- A. Quality Standard: Unless otherwise indicated, comply with WI's North American Architectural Woodwork Standards (NAAWS) for grades indicated for construction, finishes, installation, and other requirements.
  - 1. Where the Contract Documents contain requirements that are more stringent than the referenced quality standard, comply with requirements of the Contract Documents in addition to those of the referenced quality standard.
- B. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- C. Installer Qualifications: Manufacturer of products.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.07 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Composite Wood Products:
    - a. Formaldehyde emissions testing or certification.

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2.02 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Architectural Woodwork Standards Grade: Custom.
- B. Type of Construction: As indicated on drawings.
- C. Door and Drawer-Front Style: As indicated on drawings overlay.
- D. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
- E. Laminate Cladding for Exposed Surfaces:
  - 1. Horizontal Surfaces: Grade HGS.
  - 2. Postformed Surfaces: Grade HGP.
  - 3. Vertical Surfaces: Grade VGS.
- F. Materials for Semiexposed Surfaces:
  - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.
  - 2. Drawer Sides and Backs: Thermally fused laminate panels with PVC or polyester edge banding.
  - 3. Drawer Bottoms: Thermally fused laminate panels.
- G. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.
- H. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
- I. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
- J. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
  - 1. As indicated on drawings.

2.03 WOOD MATERIALS

- A. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
  - 1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
  - 2. Particleboard (Medium Density): ANSI A208.1, Grade M-2.



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3. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.04 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 08 71 00 "Door Hardware."
- B. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch- thick metal, and as follows:
  1. Semiconcealed Hinges for Flush Doors: ANSI/BHMA A156.9, B01361.
  2. Semiconcealed Hinges for Overlay Doors: ANSI/BHMA A156.9, B01521.
- C. Drawer Slides: BHMA A156.9, and as follows:
  1. General Purpose Drawer Slides: Grade 1HD-100, side mounted; full-extension type; hold-in detent; progressive movement; zinc-plated steel ball-bearing slides.
    - a. Basis-of-Design Product: Accuride Model 7432.
  2. File Drawer Slides: Grade 1HD-100; for drawers up to 24 inches wide.
    - a. Basis-of-Design Product: Accuride Model 4034.
  3. File Drawer Slides: Grade 1HD-200; for drawers more 24 inches wide.
    - a. Basis-of-Design Product: Accuride Model 3640A.
  4. Pencil Drawer Slides: Grade 1; for drawers not more than 3 inches high and 24 inches wide.
    - a. Basis-of-Design Product: Accuride Model 3832.
- D. Door Locks: ANSI/BHMA A156.11, E07121.
- E. Drawer Locks: ANSI/BHMA A156.11, E07041.
- F. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- G. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for BHMA finish number indicated.
  1. Satin Stainless Steel: ANSI/BHMA 630.
- H. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.05 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

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- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

2.06 FABRICATION

- A. Fabricate architectural cabinets to dimensions, profiles, and details indicated. Ease edges and corners to 1/16-inch radius unless otherwise indicated.
- B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
  - 1. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
- C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.02 INSTALLATION

- A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
- B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with cabinet surface.
  - 1. For shop-finished items, use filler matching finish of items being installed.

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- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
  - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
  - 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

3.03 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semiexposed surfaces. Touch up finishes to restore damaged or soiled areas.

END OF SECTION



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SECTION 06 64 00 - PLASTIC PANELING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Plastic sheet paneling.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For plastic paneling and trim accessories, in manufacturer's standard sizes.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for adhesives and sealants, indicating VOC content.

1.04 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following:
  - 1. Crane Composites, Inc.
  - 2. Glasteel.
  - 3. Marlite.
  - 4. Newcourt, Inc.
  - 5. Nudo Products, Inc.
  - 6. Parkland Plastics, Inc.
- B. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.

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2.02 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Adhesives:
    - a. VOC content limits for field applications.
  - 2. Sealants:
    - a. VOC content limits for field applications.

2.03 PLASTIC SHEET PANELING

- A. Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D5319.
  - 1. Surface-Burning Characteristics: As follows when tested by a qualified testing agency according to ASTM E84. Identify products with appropriate markings of applicable testing agency.
    - a. Flame-Spread Index: 25 or less.
    - b. Smoke-Developed Index: 450 or less.
  - 2. Color: As indicated by manufacturer's designations.

2.04 ACCESSORIES

- A. Trim Accessories: Manufacturer's standard vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, and caps as needed to conceal edges.
  - 1. Color: Match panels .
- B. Adhesive: As recommended by plastic paneling manufacturer.
- C. Sealant: Mildew-resistant, single-component, neutral-curing or acid-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 07 92 00 "Joint Sealants."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.



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3.02 PREPARATION

- A. Remove wallpaper, vinyl wall covering, loose or soluble paint, and other materials that might interfere with adhesive bond.
- B. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.
- C. Clean substrates of substances that could impair adhesive bond, including oil, grease, dirt, and dust.
- D. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
- E. Lay out paneling before installing. Locate panel joints to provide equal panels at ends of walls not less than half the width of full panels.
  - 1. Mark plumb lines on substrate at trim accessory locations for accurate installation.
  - 2. Locate trim accessories to allow clearance at panel edges according to manufacturer's written instructions.

3.03 INSTALLATION

- A. Install plastic paneling according to manufacturer's written instructions.
- B. Install panels in a full spread of adhesive.
- C. Install trim accessories with adhesive. Do not fasten through panels.
- D. Fill grooves in trim accessories with sealant before installing panels, and bed inside corner trim in a bead of sealant.
- E. Maintain uniform space between panels and wall fixtures. Fill space with sealant.
- F. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION



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SECTION 07 14 13 - HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Rubberized-asphalt waterproofing membrane, reinforced.
  - 2. Drainage panels.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference:
  - 1. Conduct conference at Project site.
  - 2. Review waterproofing requirements, including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.
- C. Sample Warranties: For special warranties.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.

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- B. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- C. Protect stored materials from direct sunlight.

1.07 FIELD CONDITIONS

- A. Weather Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, or when temperature is below zero deg F.
  - 1. Do not apply waterproofing in snow, rain, fog, or mist.
- B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.08 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace waterproofing and sheet flashings that do not comply with requirements or that fail to remain watertight within specified warranty period.
  - 1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pedestal-mounted pavers on plaza decks.
  - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain waterproofing materials sheet flashings, protection course, and molded-sheet drainage panels from single source from single manufacturer.

2.02 WATERPROOFING MEMBRANE

- A. Hot Fluid-Applied, Rubberized-Asphalt Waterproofing Membrane: Single component; 100 percent solids; hot fluid-applied, rubberized asphalt.
  - 1. Basis-of-Design System: Subject to compliance with requirements, provide Henry Company; 790-11, or comparable system by one of the following:
    - a. American Hydrotech, Inc, a Sika Company.
    - b. Barrett Company.
    - c. Carlisle Coatings & Waterproofing Inc.
    - d. CETCO.
    - e. Tremco Incorporated.

2.03 AUXILIARY MATERIALS

- A. Primer: ASTM D 41/D 41M, asphaltic primer.

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- B. Elastomeric Sheet: 50-mil- minimum, uncured sheet neoprene with manufacturer's recommended contact adhesives.
- C. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum termination bars; approximately 1 by 1/8 inch thick; with stainless-steel anchors.
- D. Sealants and Accessories: Manufacturer's recommended sealants and accessories.
- E. Reinforcing Fabric: Manufacturer's recommended, spun-bonded polyester fabric.
- F. Protection Course: Manufacturer's standard, 80- to 90-mil- thick, fiberglass-reinforced rubberized asphalt or modified bituminous sheet.
- G. Liquid-Applied Flashing System: Manufacturer's recommended multicomponent, reinforced, UV stabilized poly methyl-methacrylate resin flashing compatible with waterproofing membrane and suitable for exposed conditions.
  - 1. Primer: As recommended by manufacturer.
  - 2. Reinforcing Fabric: Polyester.

2.04 DRAINAGE PANELS

- A. Composite Drainage Panels: Drainage panel acceptable to waterproofing manufacturer and consisting of a nonbiodegradable core of fused, entangled filaments or a three-dimensional dimpled drainage net; with a geotextile facing on one side with or without a polymeric film bonded to the other side.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
  - 2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D4263.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.

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- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
- D. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, and other voids.

3.03 JOINTS, CRACKS, AND TERMINATIONS

- A. Prepare and treat substrates to receive waterproofing membrane, including joints and cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.
  - 1. Adhere strip of elastomeric sheet to substrate in a layer of hot rubberized asphalt. Extend elastomeric sheet a minimum of 6 inches on each side of moving joints and cracks or joints and cracks exceeding 1/8 inch thick, and beyond deck drains and penetrations. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.
  - 2. Embed strip of reinforcing fabric into a layer of hot rubberized asphalt. Extend reinforcing fabric a minimum of 6 inches on each side of nonmoving joints and cracks not exceeding 1/8 inch thick, and beyond roof drains and penetrations.

3.04 FLASHING INSTALLATION

- A. Install elastomeric sheets at terminations of waterproofing membrane according to manufacturer's written instructions.
- B. Liquid-Applied Flashing: Install liquid-applied flashing at locations indicated and where conditions are not favorable to install sheet flashing, in accordance with manufacturer's recommendations.

3.05 MEMBRANE APPLICATION

- A. Apply primer, at manufacturer's recommended rate, over prepared substrate and allow it to dry.
- B. Heat and apply rubberized asphalt according to manufacturer's written instructions.

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- C. Reinforced Membrane: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to a thickness of 90 mils; embed reinforcing fabric, overlapping sheets 2 inches; spread another 125-mil- thick layer to provide a uniform, reinforced, seamless membrane 215 mils thick.
- D. Apply waterproofing over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.
- E. Cover waterproofing with protection course with overlapped joints before membrane is subject to construction or vehicular traffic.

3.06 DRAINAGE PANEL INSTALLATION

- A. Place and secure drainage panels, with geotextile facing away from wall or deck substrate according to manufacturer's written instructions. Use methods that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed drainage panels during subsequent construction.

3.07 FIELD QUALITY CONTROL

- A. Engage a site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions; surface preparation; and application of membrane, flashings, protection, and drainage components; furnish daily reports to Architect.
  - 1. Site representative shall measure membrane thickness with pin tester or other suitable device at least once for every 100 sq. ft. and include measurements in reports.
- B. Testing Agency: Engage a qualified testing agency to inspect substrate conditions, surface preparation, waterproofing application, protection, and drainage components, and to furnish reports to Architect.
  - 1. Electronic Leak-Detection Testing:
    - a. Testing agency shall test each deck area for leaks using an electronic leak-detection method that locates discontinuities in the waterproofing membrane.
    - b. Testing agency shall perform tests on abutting or overlapping smaller areas as necessary to cover entire test area.
    - c. Testing agency shall create a conductive electronic field over the area of waterproofing to be tested and electronically determine locations of discontinuities or leaks, if any, in the waterproofing.
    - d. Testing agency shall provide survey report indicating locations of discontinuities, if any.
  - 2. Waterproofing will be considered defective if it does not pass tests and inspections.

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3.08 CLEANING AND PROTECTION

- A. Protect waterproofing from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

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SECTION 07 14 16 - COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Methyl methacrylate waterproofing at exterior stairs.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Show locations and extent of waterproofing.
  - 2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1.03 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.05 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 TWO-COMPONENT REINFORCED METHYL METHACRYLATE WATERPROOFING

- A. Two-Component, Reinforced, Polyurethane-Modified Methyl Methacrylate (PUMA) or Polymethyl Methacrylate (PMMA) Waterproofing:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Henry Company; Pumadeq System, or comparable product by one of the following:
    - a. American Hydrotech, Inc, a Sika Company.
    - b. Barrett Company.

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- c. Carlisle Coatings & Waterproofing Inc.
- d. CETCO.
- e. Tremco Incorporated.

2.02 AUXILIARY MATERIALS

- A. Primer: Manufacturer's standard primer, sealer, or surface conditioner; factory-formulated acrylic latex, polyurethane, or epoxy.
- B. Membrane-Reinforcing Fabric: Manufacturer's recommended polyester fabric.
- C. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing; and as recommended by manufacturer for substrate and joint conditions.
  - 1. Backer Rod: Closed-cell polyethylene foam.
- D. Surface Conditioner: Manufacturer's standard surface conditioner or sand broadcast to enhance bonding of precast adhesive or mortar setting material.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
- D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.
- E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.
- F. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners according to waterproofing manufacturer's written instructions.
- G. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

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- H. Prepare, treat, rout, and fill joints and cracks in substrate according to waterproofing manufacturer's written instructions. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.

3.02 WATERPROOFING APPLICATION

- A. Apply waterproofing according to manufacturer's written instructions.
- B. Reinforced Waterproofing Applications:
  - 1. Apply first coat of waterproofing, embed membrane-reinforcing fabric, and apply second coat of waterproofing to completely saturate reinforcing fabric and to obtain a seamless reinforced membrane free of entrapped gases and pinholes, with an average dry film total thickness of 80 mils.

3.03 PROTECTION

- A. Protect waterproofing from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION

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SECTION 07 16 16 - CRYSTALLINE WATERPROOFING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Crystalline waterproofing for negative-side application to concrete at elevator pit.
- B. Related Sections:
  - 1. Division 03 Section "Cast-in-Place Concrete" for ready-mixed concrete requirements.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. Include construction details, material descriptions, and installation instructions.

1.03 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Product Test Reports: For water permeability.
- C. Field Quality-Control Reports: From field quality-control inspections.

1.04 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm experienced in applying crystalline waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

1.05 FIELD CONDITIONS

- A. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.
- B. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 40 deg F or above during work and cure period, and space is well ventilated and kept free of water.



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1.06 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
1. Warranty Period: 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 NEGATIVE-SIDE CRYSTALLINE WATERPROOFING MATERIALS

- A. Negative-Side Crystalline Waterproofing: Prepackaged, gray-colored proprietary blend of portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates into concrete and concrete unit masonry and reacts chemically with the byproducts of cement hydration in the presence of water to develop crystalline growth within substrate capillaries to produce an impervious, dense, waterproof substrate; with properties meeting or exceeding the criteria specified below.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. KOSTER American Corporation; KOSTER NB 1 Grey.
    - b. Kryton International Inc.; Krystol T1 Waterproofing System.
    - c. Xypex Chemical Corporation; Xypex.
  2. Water Permeability: Maximum zero for water at 30 feet when tested according to CE CRD-C 48.

2.02 ACCESSORY MATERIALS

- A. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; compatible with substrate and other materials indicated.
- B. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); compatible with substrate and other materials indicated.
- C. Portland Cement: ASTM C 150, Type I.
- D. Sand: ASTM C 144.
- E. Water: Potable.



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2.03 MIXES

- A. Negative-Side Crystalline Waterproofing: Add prepackaged dry ingredients to water according to manufacturer's written instructions. Mix together with mechanical mixer or by hand to required consistency.
- B. Protective Topping: Measure, batch, and mix portland cement and sand in the proportion of 1:3 and water. Blend together with mechanical mixer to required consistency.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to ensure adequate ambient temperatures and ventilation conditions for application.
- B. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.
- C. Stop active water leaks with plugging compound according to waterproofing manufacturer's written instructions.
- D. Repair damaged or unsatisfactory substrate with patching compound according to manufacturer's written instructions.
- E. Surface Preparation: Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.

3.02 NEGATIVE-SIDE APPLICATION

- A. General: Comply with waterproofing manufacturer's written instructions for application and curing.
  - 1. Saturate surface with water for several hours prior to application and maintain damp condition until applying waterproofing. Remove standing water.
  - 2. Apply waterproofing to surfaces indicated on Drawings.
  - 3. Number of Coats: Number required for specified water permeability, but not less than two.
  - 4. Application Method: Brush. Apply to ensure that each coat fills voids and is in full contact with substrate or previous coat.
  - 5. Dampen surface between coats.
- B. Final Coat Finish: Brushed.

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CRYSTALLINE WATERPROOFING  
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- C. Curing: Moist-cure waterproofing for three days immediately after final coat has set, followed by air drying, unless otherwise recommended in writing by manufacturer.
- D. Waterproofing Treatment Extensions: Extend waterproofing treatment as follows:
  - 1. Onto columns integral with treated walls.
  - 2. Onto every substrate in areas indicated for treatment, including sumps and similar offsets and features.
- E. Protective Topping: Apply 1-inch- thick, protective topping over floor surfaces.

3.03 FIELD QUALITY CONTROL

- A. Inspection: Engage manufacturer's representative to inspect completed application and provide a written report that application complies with manufacturer's written instructions.

END OF SECTION



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SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Insulation in cavities formed by framing members.
  - 2. Exterior continuous insulation.
- B. Related Sections:
  - 1. Division 07 Sections: For insulation specified as part of roofing and horizontal waterproofing assemblies.
  - 2. Section 09 81 00 "Acoustic Insulation" for sound attenuation insulation.
  - 3. Division 22 and 23 Sections: For pipe and duct insulation.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for insulation, indicating compliance with emissions testing or certification.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

1.04 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Insulation:
    - a. VOC emissions testing or certification.

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THERMAL INSULATION  
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2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Provide exterior wall assemblies with foam plastic insulation with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

2.03 INSULATION IN CAVITIES FORMED BY FRAMING MEMBERS

- A. Unfaced, Glass-Fiber Blanket Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
1. Locations: Where indicated, and as follows:
    - a. Cavities formed with stud framing members.
- B. Mineral-Wool Blanket Insulation, Unfaced: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
1. Locations: Where indicated, and as follows:
    - a. Cavities formed with stud framing members.

2.04 EXTERIOR CONTINUOUS INSULATION

- A. High Density, Unfaced, Semi-Rigid Mineral-Wool Board Insulation: ASTM C612, Type IVA or IVB; with maximum flame-spread and smoke-developed indexes of 0; and of the following nominal density and thermal resistivity:
1. Nominal density of 11 lb/cu. ft., thermal resistivity of 4.0 deg F x h x sq. ft./Btu x in. at 75 deg F.
  2. Locations: Where indicated, and as follows:
    - a. Continuous insulation between exterior cladding and sheathing.
  3. Product: Provide one of the following:
    - a. Owens Corning; Thermafiber RainBarrier ci High Compressive Plus (110).
    - b. Rockwool; Comfortboard 110.
- B. Fasteners:
1. Cavity-Wall Fasteners: Corrosion-resistant fasteners recommended by insulation manufacturer for intended use consisting of 1-3/4 inch diameter plastic cap, and fastener indicated below.
    - a. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
      - 1) Wind-Lock Corporation; ci-Lock Steel Series Selection.



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PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.02 INSTALLATION OF EXTERIOR CONTINUOUS INSULATION

- A. Mineral-Wool Board Insulation: Install insulation fasteners 4 inches from each corner of board insulation, at center of board, and as recommended by manufacturer.
  - 1. Fit courses of insulation between obstructions, with edges butted tightly in both directions, and with faces flush.
  - 2. Press units firmly against inside substrates.

3.03 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions and according to ASTM C1320. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
  - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
  - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
  - 3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
  - 4. For wall cavities where cavity heights exceed 96 inches, support unfaced glass fiber blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

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- C. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation.
1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.

END OF SECTION



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SECTION 07 25 00 - WEATHER BARRIERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Self-adhering weather barriers.
- B. Related Sections:
  - 1. 076500 - Flexible Flashing: For flexible flashings not part of weather barrier assemblies.

1.02 DEFINITIONS

- A. Weather Barrier: Material within the exterior envelope assembly that performs as a water-resistive and air barrier, primarily to mitigate the consequences of bulk water intrusion through cladding systems and air movement through assemblies.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For weather barrier assemblies.
  - 1. Show locations and extent of weather barrier. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports: From manufacturer's technical personnel.
- B. Sample Warranties.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by weather barrier system manufacturer to install manufacturer's product.

1.06 PRECONSTRUCTION TESTING

- A. Mockup Testing: Weather barrier assemblies shall comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.
  - 1. Mockups will be tested for air-leakage rate according to ASTM E2357.

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1.07 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of weather barriers that fail in materials or workmanship within specified warranty period.
1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. General: Weather barrier shall be capable of performing as a continuous barrier to air, water, and perform as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Weather barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Weather Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested according to ASTM E2357.
- C. Self-Adhering Flexible Flashing Performance: Self-adhering flexible flashing shall meet minimum performance requirements when tested according to AAMA 711.
- D. Fluid-Applied Flashing Performance: Fluid-applied flashing shall meet minimum performance requirements when tested according to AAMA 714.

2.02 SELF-ADHERING POLYPROPYLENE SHEET WEATHER BARRIERS

- A. Self-Adhering, Multi-Layer, Vapor-Permeable Polypropylene Sheet: Self-adhering sheet consisting of multiple layers of spun-bonded polypropylene fabric with full surface coating of pressure sensitive adhesive with release liner on adhesive side.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
- a. Dorken; Delta-Vent SA.
- b. Vaproshield; Wrapshield SA.
- c. GCP Applied Technologies; Perm-A-Barrier VPS.
- B. Detailing Accessories: Self-adhering membranes, liquid flashing membranes, and sealants recommended by manufacturer for sealing joints and penetrations in weather barrier.

2.03 ACCESSORY MATERIALS

- A. General: Accessory materials recommended by weather barrier manufacturer to produce a complete weather barrier assembly and compatible with weather barrier membrane.

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PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

3.02 SURFACE PREPARATION

- A. Mask off adjoining surfaces not covered by weather barrier to prevent spillage and overspray affecting other construction.
- B. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- C. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- D. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
- E. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

3.03 SELF-ADHERING WEATHER BARRIER INSTALLATION

- A. General: Install modified bituminous sheets and accessory materials according to weather barrier manufacturer's written instructions.
  - 1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering weather barrier sheet produced for low-temperature application. Do not install low-temperature sheet if ambient or substrate temperature is higher than 60 deg F.
- B. Apply primer to substrates when required by weather barrier manufacturer in accordance with manufacturer's instructions.
- C. Apply and firmly adhere sheets horizontally over area to receive weather barrier. Accurately align sheets and maintain uniform minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure airtight installation.
  - 1. Apply sheets in a shingled manner to shed water without interception by any exposed sheet edges.
  - 2. Roll sheets firmly to enhance adhesion to substrate.
- D. Seal top of through-wall flashings to weather barrier sheet.
- E. Install weather barrier sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous air and weather barrier.

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- F. Do not cover weather barrier until it has been inspected by manufacturer's technical personnel.
- G. Correct deficiencies in or remove weather barrier that does not comply with requirements; repair substrates and reapply weather barrier components.

3.04 FIELD QUALITY CONTROL

- A. Inspections: Arrange for weather barrier system manufacturer's technical personnel to inspect weather barrier installation on completion.
- B. Repair or remove and replace components of weather barrier system where inspections indicate that they do not comply with specified requirements.

3.05 CLEANING AND PROTECTION

- A. Protect weather barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
  - 1. Protect weather barrier from exposure to UV light and harmful weather exposure as required by manufacturer. Remove and replace weather barrier exposed for more than days allowed by manufacturer.
  - 2. Protect weather barrier from contact with incompatible materials and sealants not approved by weather barrier manufacturer.

END OF SECTION



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SECTION 07 26 00 - VAPOR RETARDERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Underslab vapor retarders.
- B. Related Sections:
  - 1. Division 31 Section "Earth Moving" for drainage fill and subbase under slabs-on-grade.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.01 UNDERSLAB VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
  - 1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Fortifiber Building Systems Group; Moistop Ultra.
    - b. Insulation Solutions, Inc.; Viper VaporCheck.
    - c. Meadows, W. R., Inc.; Perminator.
    - d. Raven Industries Inc.; Vapor Block.
    - e. Stego Industries, LLC; Stego Wrap.

2.02 ACCESSORIES

- A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- B. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.



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PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean substrates of substances that are harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.02 INSTALLATION OF UNDERSLAB VAPOR RETARDERS

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
  - 1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.03 PROTECTION

- A. Protect vapor retarders from damage until concealed by permanent construction.

END OF SECTION



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SECTION 07 41 13.16 - STANDING-SEAM METAL ROOFING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Standing-seam metal roofing system including the following:
  - 1. Formed metal roofing panels.
  - 2. Roof insulation.
  - 3. Air barrier / vapor retarder.
  - 4. Substrate board.

1.02 DEFINITIONS

- A. Metal Roofing System: Metal roof panels, attachment system components, underlayment, thermal insulation and accessories necessary for a complete weathertight roofing system.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, insulation, and accessories; and special details and the following:
  - 1. Thickness of insulation.
  - 2. Tie-in with adjoining air barrier.
- C. Samples: For each type of metal panel indicated.

1.04 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Warranties: Sample of special warranties.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

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1.07 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
  - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:
  - 1. Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than 0.75.
  - 2. Three-year, aged Solar Reflectance Index of not less than 64 when calculated according to ASTM E1980.
- B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
  - 1. Wind Loads: As indicated on Drawings.
  - 2. Other Design Loads: As indicated on Drawings.
  - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E1680 at the following test-pressure difference:
  - 1. Test-Pressure Difference: 1.57 lbf/sq. ft..
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 at the following test-pressure difference:
  - 1. Test-Pressure Difference: 6.24 lbf/sq. ft..
- E. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.

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- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.02 STANDING-SEAM METAL ROOF PANELS

- A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.
- B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
1. Basis-of-Design Product: Subject to compliance with requirements, provide McElroy Metal; Model 238T, or comparable product by approved manufacturer.
  2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
    - a. Nominal Thickness: 0.028 inch.
    - b. Exterior Finish: Two-coat fluoropolymer .
    - c. Color: Slate Gray.
  3. Clips: One-piece fixed to accommodate thermal movement.
    - a. Material: 0.064-inch- nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
  4. Joint Type: As standard with manufacturer.
  5. Panel Coverage: As indicated.
  6. Panel Height: 2.375 inches.

2.03 AIR BARRIER / VAPOR RETARDER

- A. Self-Adhering-Sheet Air Barrier / Vapor Retarder: ASTM D 1970, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 30-mil-total thickness; cold applied, with slip-resisting surface compatible with adhered insulation and release paper backing. Provide primer when recommended by manufacturer.
1. Mastic: Type recommended by manufacturer for sealing penetrations and terminations in air barrier / vapor retarder.



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2.04 FIELD-INSTALLED METAL ROOFING INSULATION

- A. Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1 or 2 felt or glass-fiber mat, Grade 3, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core.

2.05 SUBSTRATE BOARDS

- A. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M.

2.06 MISCELLANEOUS MATERIALS

- A. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
  - 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
  - 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
  - 3. Pressure Plates: Provide metal pressure plates beneath clips, fabricated from material recommended by manufacturer.
  - 4. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- C. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- D. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
  - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch wide and 1/8 inch thick.
  - 2. Joint Sealant: ASTM C920; as recommended in writing by metal panel manufacturer.
  - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.



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2.07 FABRICATION

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.08 FINISHES

- A. Panels and Accessories:
  - 1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat.
  - 2. Concealed Finish: White or light-colored acrylic or polyester backer finish.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Substrate Board: Install substrate boards over roof deck on entire roof surface. Attach with substrate-board fasteners.
  - 1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

3.02 AIR BARRIER / VAPOR RETARDER INSTALLATION

- A. Air Barrier / Vapor Retarder: Install over substrate board. Extend air barrier / vapor retarder to cover entire roof. Tie into building air barrier at transitions from roofing to adjacent construction. Repair tears or punctures immediately before concealment by other work.

3.03 ROOFING INSULATION INSTALLATION

- A. Board Insulation: Place insulation in thickness indicated to cover entire roof.

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- B. Install roof panel clips and pressure plates over insulation in accordance with manufacturer's instructions.

3.04 INSTALLATION OF STANDING SEAM METAL ROOF PANELS

- A. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
  - 1. Install clips to supports with self-tapping fasteners.
  - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
  - 3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
  - 4. Watertight Installation:
    - a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
    - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
    - c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.
- B. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
- C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.05 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. Touch up minor scratches and abrasions in finishes in accordance with finish manufacturer's instructions.

END OF SECTION

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SECTION 07 42 13.13 - FORMED METAL WALL PANELS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Formed metal wall panels.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
  - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
  - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.
- C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied finishes.
  - 1. Include Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below:
  - 1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

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1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

1.06 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.07 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including rupturing, cracking, or puncturing.
    - b. Deterioration of metals and other materials beyond normal weathering.
  - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.

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- c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
- 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
  - 1. Wind Loads: As indicated on Drawings.
  - 2. Other Design Loads: As indicated on Drawings.
  - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

### 2.02 METAL WALL PANELS

- A. Provide factory-formed metal panels designed to be field assembled by interconnecting side edges of panels to supports using formed edges with factory-applied gasket between adjacent panels. Include accessories required for weathertight installation.
- B. Flush-Profile Metal Wall Panels: Formed with a flat pan between panel edges; with flush butt joint between panels.
  - 1. Basis-of-Design Product: As indicated on Drawings.
  - 2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
    - a. Nominal Thickness: 0.028 inch .
    - b. Exterior Finish: Two-coat fluoropolymer .
    - c. Color: As selected by Architect from manufacturer's full range.

### 2.03 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

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- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
  - 1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
  - 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
  - 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
  - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
  - 2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
  - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.04 FABRICATION

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

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- D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
  2. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
    - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.05 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
1. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
    - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

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- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.03 INSTALLATION

- A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
  - 1. Shim or otherwise plumb substrates receiving metal panels.
  - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
  - 3. Install screw fasteners in predrilled holes.
  - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
  - 5. Install flashing and trim as metal panel work proceeds.
  - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
  - 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
  - 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
  - 1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal wall panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.



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- D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
  2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.04 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION



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SECTION 07 42 46.16 - FIBER CEMENT WALL PANELS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Fiber cement wall panels.
- B. Related Sections:
  - 1. Section 07 60 00 "Flashing and Sheet Metal" for field-formed flashings and other sheet metal work not part of wall panel assemblies.

1.02 SYSTEM DESCRIPTION

- A. Fiber Cement Wall Panel Assembly: Fiber cement wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete ventilated fiber cement wall cladding system.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings: Include fabrication and installation layouts of fiber cement wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
- C. Samples: For each type of fiber cement panel indicated.

1.04 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Sample Warranties: For special warranties.
- C. Delegated-Design Submittal: For fiber cement wall panel assemblies, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of fiber cement wall panel from single source from single manufacturer.

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- B. Preinstallation Conference: Conduct conference at Project site.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, fiber cement wall panels, and other manufactured items so as not to be damaged or deformed. Package panels for protection during transportation and handling.
- B. Unload, store, and erect fiber cement wall panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack fiber cement wall panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store panels to ensure dryness, with positive slope for drainage of water. Do not store panels in contact with other materials that might cause staining or other surface damage.

1.07 PROJECT CONDITIONS

- A. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before fiber cement wall panel fabrication and indicate measurements on Shop Drawings.

1.08 COORDINATION

- A. Coordinate fiber cement wall panel assemblies with flashing, trim, construction of studs, and other adjoining work.

1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fiber cement wall panel assemblies that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures, including rupturing, cracking, or puncturing.
    - b. Deterioration of metals and other materials beyond normal weathering.
  - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. General Performance: Fiber cement wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

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- B. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design fiber cement wall panel assemblies.
- C. Structural Performance: Provide fiber cement wall panel assemblies capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
  - 1. Wind Loads: As indicated on Drawings.
  - 2. Other Design Loads: As indicated on Drawings.
  - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- D. Seismic Performance: Rainscreen cladding assembly shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.02 FIBER CEMENT WALL PANELS

- A. Fiber Cement Wall Panels: Provide factory-formed, fiber cement wall panels fabricated from sheets formed into profile for installation method indicated. Include attachment system components and accessories required for complete system.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product as indicated on Drawings, or comparable product by approved manufacturer.
  - 2. Material: Fiber cement, silicon-calcium strengthened with a combination of polyvinyl fibers without asbestos, fiberglass or formaldehyde.
  - 3. Panel Size: As indicated.
  - 4. Panel Thicknesses: 16 mm.
  - 5. Exterior Finish: Factory-applied in color as indicated by manufacturer's designations.

2.03 MISCELLANEOUS METAL FRAMING

- A. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G90hot-dip galvanized or coating with equivalent corrosion resistance unless otherwise indicated.

2.04 MISCELLANEOUS MATERIALS

- A. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and finish indicated.

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- B. Panel Fasteners: Self-tapping screws; bolts and nuts; self-locking rivets and bolts; end-welded studs; and other suitable fasteners designed to withstand design loads.
- C. Fasteners: Manufacturer's standard, corrosion resistant fasteners, color as selected by Architect from full color range.

2.05 ACCESSORIES

- A. Fiber Cement Wall Panel Accessories: Provide components required for a complete fiber cement wall panel assembly including trim, copings, fasciae, mullions, sills, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. Flashing and Trim: Prefinished galvanized steel or aluminum, same color as adjacent fiber cement wall panels, minimum 0.030 inch thick unless otherwise indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, fiber cement wall panel supports, and other conditions affecting performance of the Work.
- B. Examine roughing-in for components and systems penetrating fiber cement wall panels to verify actual locations of penetrations relative to seam locations of panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous fiber cement wall panel support members and anchorage according to ASTM C 754 and panel manufacturer's written instructions.

3.03 FIBER CEMENT WALL PANEL INSTALLATION

- A. General: Install fiber cement wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.
  - 1. Commence fiber cement wall panel installation and install minimum of 300 sq. ft. in presence of factory-authorized representative.
  - 2. Shim or otherwise plumb substrates receiving fiber cement wall panels.
  - 3. Install flashing and trim as fiber cement wall panel work proceeds.

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4. Install with exposed fasteners.

- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by fiber cement wall panel manufacturer.
- C. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by panel manufacturer.
- D. Attachment System, General: Install attachment system required to support fiber cement wall panels, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
  - 1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.

3.04 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align fiber cement wall panel units within installed tolerance of 1/4 inch in 20 feet, noncumulative, on level, plumb, and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed fiber cement wall panel installation, including accessories.
- B. Fiber cement wall panels will be considered defective if they do not pass inspections.
- C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION



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SECTION 07 42 93 - SOFFIT PANELS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Metal soffit panels.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
  - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
  - 2. Accessories: Include details of flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
  - 1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, tests performed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

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1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

1.07 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.08 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.09 WARRANTY

- A. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.



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PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
  - 1. Wind Loads: As indicated on Drawings.
  - 2. Other Design Loads: As indicated on Drawings.
  - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.02 METAL SOFFIT PANELS

- A. Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.
- B. Flush-Profile Metal Soffit Panels : Solid panels formed with vertical panel edges and a flat pan between panel edges; with flush joint between panels.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by approved manufacturer.
  - 2. Aluminum Sheet: Coil-coated sheet, ASTM B209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
    - a. Color: As indicated by manufacturer's designations.

2.03 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

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1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- E. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
  1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
  2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
  3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.04 FABRICATION

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
  1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

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2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
  - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal soffit panel manufacturer for application but not less than thickness of metal being secured.

2.05 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Aluminum Panels and Accessories:
  1. Baked Powder Coat: AAMA 2605; Hyper durable polyurethane powder coat.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
  1. Examine framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.
  2. Examine sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal panel manufacturer.
    - a. Verify that air- or water-resistive barriers been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

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- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.03 INSTALLATION

- A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
  - 1. Shim or otherwise plumb substrates receiving metal panels.
  - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
  - 3. Install screw fasteners in predrilled holes.
  - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
  - 5. Install flashing and trim as metal panel work proceeds.
  - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
  - 7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
  - 1. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
  - 1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.



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- E. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
1. Install exposed flashing and trim that is without buckling, and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
  2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.04 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION



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SECTION 07 54 19 - POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Polyvinyl-chloride roofing membrane assembly including the following:
  - 1. Adhered polyvinyl chloride (PVC) roofing system.
  - 2. Substrate board.
  - 3. Air barrier / vapor retarder.
  - 4. Roof insulation.
  - 5. Cover board.
  - 6. Walkways.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
  - 2. Division 06 Sections for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
  - 3. Division 06 Sections for wood-based, structural-use roof deck panels.
  - 4. Section 07 21 00 "Thermal Insulation" for insulation beneath the roof deck.
  - 5. Division 22 Sections for roof drains.

1.02 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
  - 1. Layout and thickness of insulation.
  - 2. Flashings and membrane termination details.
  - 3. Flashing details at penetrations.
  - 4. Tapered insulation layout, thickness, and slopes.
  - 5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
  - 6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
  - 7. Tie-in with adjoining air barrier.

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- C. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.04 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for adhesives and sealants, indicating VOC content.
- B. Manufacturer Certificates:
  - 1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
    - a. Submit evidence of compliance with performance requirements.
  - 2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
- C. Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.
- D. Field quality-control reports.
- E. Sample Warranties: For manufacturer's special warranties.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
  - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

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- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.08 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
  - 1. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, cover boards, air barrier / vapor retarder, and other components of roofing system.
  - 2. Warranty Period: 20 years from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, roof insulation, fasteners, cover boards, air barriers / vapor retarders, and walkway products, for the following warranty period:
  - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Adhesives:
    - a. VOC content limits for field applications.
  - 2. Sealants:
    - a. VOC content limits for field applications.

2.02 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing system and flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings shall remain watertight.
  - 1. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.

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2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials shall comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and shall be listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: Class 1A-90.

## 2.03 POLYVINYL CHLORIDE (PVC) ROOFING

A. PVC Sheet: ASTM D4434/D4434M, Type II, glass-fiber reinforced, felt backed.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Sika Sarnafil G410 Feltback or comparable product by one of the following:

a. Carlisle.

b. Firestone.

2. Thickness: 72 mils.

3. Exposed Face Color: White .

a. Fibertite.

B. PVC Keytone Ethylene Ester (KEE)- Alloy Sheet: ASTM D4434/D4434M, Type III, with fabric backing.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Carlisle Sure-Flex KEE HP Fleeceback or comparable product by one of the following:

a. Seaman Corp; Fibertite.

2. Membrane Thickness: 60 mils.

a. Fabric Backing Thickness: 55 mils.

3. Exposed Face Color: White.

C. Source Limitations: Obtain components for roofing system from roof membrane manufacturer or manufacturers approved by roof membrane manufacturer.

## 2.04 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.

1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.

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- B. Sheet Flashing: Manufacturer's standard unreinforced PVC sheet flashing, 55 mils thick, minimum, of same color as PVC sheet.
- C. Liquid-Applied Flashing: Manufacturer's standard reinforced flashing, 80 mils thick, minimum.
- D. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- E. Bonding Adhesive: Manufacturer's standard.
- F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.
- H. Miscellaneous Accessories: Provide preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.05 SUBSTRATE BOARDS

- A. Substrate Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M, fiber-reinforced gypsum board, as recommended by roofing membrane manufacturer.
  - 1. Thickness: Type X, 5/8 inchthick.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.06 AIR BARRIER / VAPOR RETARDER

- A. Sheet Air Barrier / Vapor Retarder: Manufacturer's recommended SBS-modified bitumen sheet product, minimum 30-mil-total thickness; self-adhering, cold adhesive applied, or torch applied, with slip-resisting surface compatible with adhered insulation and release paper backing. Provide primer when recommended by manufacturer.
  - 1. Mastic: Type recommended by manufacturer for sealing penetrations and terminations in air barrier / vapor retarder.

2.07 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by PVC roof membrane manufacturer.

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- B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
  - 1. Compressive Strength: 20 psi, minimum.
- C. Tapered Insulation: Provide factory-tapered insulation boards.
  - 1. Material: Match roof insulation.
  - 2. Minimum Thickness: 1/4 inch.
  - 3. Slope:
    - a. Roof Field: 1/4 inch per foot unless otherwise indicated on Drawings.
    - b. Saddles and Crickets: 1/2 inch per foot unless otherwise indicated on Drawings.

## 2.08 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- B. Fasteners: Factory-coated steel fasteners with metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
  - 1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
- D. Cover Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M fiber-reinforced gypsum board.
  - 1. Thickness: 1/4 inch.

## 2.09 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick and acceptable to roofing system manufacturer.
  - 1. Size: Approximately 36 by 60 inches.
  - 2. Color: Contrasting with roof membrane.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

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1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section steel decking.
4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
5. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than 75 percent, or as recommended by roofing system manufacturer, when tested according to ASTM F2170.
  - a. Test Frequency: One test probe per each 1000 sq. ft., or portion thereof, of roof deck, with not less than three tests probes.
  - b. Submit test reports within 24 hours after performing tests.
6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
7. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

### 3.03 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.
- C. Coordinate installation and transition of roofing system component serving as an air barrier with adjacent air barrier material and assemblies

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3.04 INSTALLATION OF SUBSTRATE BOARD

- A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.
  - 1. At steel roof decks, install substrate board at right angle to flutes of deck.
    - a. Locate end joints over crests of steel roof deck.
  - 2. Tightly butt substrate boards together.
  - 3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - 4. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29.
  - 5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.
  - 6. Loosely lay substrate board over roof deck.

3.05 INSTALLATION OF AIR BARRIER / VAPOR RETARDER

- A. Self-Adhering-Sheet: Prime substrate if required by manufacturer. Install sheet over area to receive air barrier / vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches, respectively.
  - 1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
  - 2. Seal laps by rolling.
  - 3. Tie to adjacent air barrier materials and assemblies.
- B. Completely seal air barrier / vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.06 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
  - 1. Install base layer of insulation with end joints staggered not less than 12 inches in adjacent rows.

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- a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
  - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
  - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
    - 1) Trim insulation so that water flow is unrestricted.
  - e. Fill gaps exceeding 1/4 inch with insulation.
  - f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
  - g. Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
    - 1) Fasten insulation according to requirements in FM Approvals' RoofNav for specified Windstorm Resistance Classification.
    - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
- a. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
  - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
  - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
    - 1) Trim insulation so that water flow is unrestricted.
  - e. Fill gaps exceeding 1/4 inch with insulation.
  - f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
  - g. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
    - 1) Set each layer of insulation in insulation adhesive, firmly pressing and maintaining insulation in place.

D. Installation Over Concrete Decks:

- 1. Install base layer of insulation with end joints staggered not less than 12 inches in adjacent rows.

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- a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
  - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
  - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
    - 1) Trim insulation so that water flow is unrestricted.
  - e. Fill gaps exceeding 1/4 inch with insulation.
  - f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
  - g. Adhere base layer of insulation to concrete roof deck according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
    - 1) Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft., and allow primer to dry.
    - 2) Set insulation in insulation adhesive, firmly pressing and maintaining insulation in place.
2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
- a. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
  - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
  - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
    - 1) Trim insulation so that water flow is unrestricted.
  - e. Fill gaps exceeding 1/4 inch with insulation.
  - f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
  - g. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
    - 1) Set each layer of insulation in insulation adhesive, firmly pressing and maintaining insulation in place.

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3.07 INSTALLATION OF COVER BOARDS

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.
  - 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - 2. At internal roof drains, conform to slope of drain sump.
    - a. Trim cover board so that water flow is unrestricted.
  - 3. Cut and fit cover board tight to nailers, projections, and penetrations.
  - 4. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
    - a. Set cover board in insulation adhesive, firmly pressing and maintaining insulation in place.

3.08 INSTALLATION OF ADHERED ROOF MEMBRANE

- A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll roof membrane and allow to relax before installing.
- C. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.
- F. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer, and install fabric-backed roof membrane.
- G. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.
- H. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- I. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings, to ensure a watertight seam installation.

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1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
  2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
  3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.
- J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.09 INSTALLATION OF BASE FLASHING

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.10 INSTALLATION OF WALKWAYS

- A. Flexible Walkways:
  1. Install flexible walkways at the following locations:
    - a. Retain one or more subparagraphs below. Revise to suit Project.
    - b. Perimeter of each rooftop unit.
    - c. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
    - d. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
    - e. Top and bottom of each roof access ladder.
    - f. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
    - g. Locations indicated on Drawings.
    - h. As required by roof membrane manufacturer's warranty requirements.
  2. Provide 6-inch clearance between adjoining pads.
  3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

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3.11 FIELD QUALITY CONTROL

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
- B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.12 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

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SECTION 07 60 00 - FLASHING AND SHEET METAL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Manufactured Products:
    - a. Manufactured reglets and counterflashing.
  - 2. Formed Products:
    - a. Formed sheet metal fabrications.
- B. Related Sections:
  - 1. Section 07 71 00 "Roof Specialties" for manufactured roof sheet metal fabrications.
  - 2. Section 07 65 00 "Flexible Flashing" for flexible flashing membranes.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation layouts of flashing and sheet metal, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
  - 1. Include details for forming, joining, supporting, and securing flashing and sheet metal, including pattern of seams, termination points, fixed points, expansion joints, expansion-joint covers, edge conditions, special conditions, and connections to adjoining work.
  - 2. Include identification of material, thickness, weight, and finish for each item.
- C. Samples: For each exposed product and for each finish specified.

1.03 INFORMATIONAL SUBMITTALS

- A. Maintenance data.

1.04 QUALITY ASSURANCE

- A. Flashing and Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.



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PART 2 - PRODUCTS

2.01 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
  - 1. Exposed Coil-Coated Finishes: Fluoropolymer.
    - a. Color: Custom color as selected by Architect to match adjacent surfaces.
- C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed; 2B (bright, cold rolled) finish.
- D. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
  - 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
  - 2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; structural quality.
  - 3. Exposed Finish: Fluoropolymer.
    - a. Color: Custom color as selected by Architect to match adjacent surfaces.

2.02 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete flashing and sheet metal installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
  - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
    - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
    - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
  - 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
  - 3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
  - 4. Fasteners for Metallic-Coated Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.

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- C. Solder:
  - 1. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- E. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in flashing and sheet metal and remain watertight.
- F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- H. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.03 REGLETS

- A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with interlocking counterflashing on exterior face, of same metal as reglet.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cheney Flashing Company.
    - b. Fry Reglet Corporation.
    - c. Heckmann Building Products Inc.
    - d. Hickman, W. P. Company.
    - e. Hohmann & Barnard, Inc.; STF Sawtooth Flashing.
    - f. Keystone Flashing Company, Inc.
    - g. National Sheet Metal Systems, Inc.
    - h. Sandell Manufacturing Company, Inc.
  - 2. Material: Stainless steel, 0.019 inch thick.
  - 3. Finish: Mill.



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2.04 FABRICATION, GENERAL

- A. General: Custom fabricate flashing and sheet metal to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
  - 1. Obtain field measurements for accurate fit before shop fabrication.
  - 2. Form flashing and sheet metal without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
  - 3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
- B. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
- C. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
- D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- E. Stainless Steel Sheet Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- F. Painted or Coated Sheet Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

2.05 SHEET METAL FABRICATIONS

- A. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters.
  - 1. Expansion Joints: Lap type.
  - 2. Accessories: Wire ball downspout strainer.
  - 3. Gutters with Girth up to 15 Inches: Fabricate from one of the following materials:
    - a. Aluminum: 0.032 inch thick.
    - b. Galvanized Steel: 0.022 inch thick.
    - c. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.
  - 4. Gutters with Girth 16 to 20 Inches: Fabricate from the following materials:
    - a. Aluminum: 0.040 inch thick.



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- b. Galvanized Steel: 0.028 inch thick.
  - c. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.
- B. Downspouts: Fabricate downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
  - 1. Fabricate from one of the following materials:
    - a. Aluminum: 0.024 inch thick.
    - b. Galvanized Steel: 0.022 inch thick.
    - c. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.
- C. Copings: Fabricate in minimum 96-inch- long, but not exceeding 10-foot- long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight. Fabricate from the following materials:
  - 1. Joint Style: Butt, with 12-inch- wide, concealed backup plate.
  - 2. Fabricate from the following material:
    - a. Aluminum: 0.050 inch thick, minimum.
- D. Base Flashing: Fabricate from one of the following materials:
  - 1. Aluminum: 0.040 inch thick.
  - 2. Galvanized Steel: 0.028 inch thick.
  - 3. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.
- E. Counterflashing: Fabricate from the following materials:
  - 1. Aluminum: 0.032 inch thick.
  - 2. Stainless Steel: 0.019 inch thick.
  - 3. Galvanized Steel: 0.022 inch thick.
- F. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from one of the following materials:
  - 1. Aluminum: 0.032 inch thick.
  - 2. Galvanized Steel: 0.022 inch thick.
  - 3. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION, GENERAL

- A. General: Anchor flashing and sheet metal and other components of the Work securely in place, with provisions for thermal and structural movement so that completed flashing and sheet metal shall not rattle, leak, or loosen, and shall remain watertight. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete flashing and sheet metal system.
  - 1. Install flashing and sheet metal true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.

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2. Install flashing and sheet metal to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
  3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
  4. Install exposed flashing and sheet metal without excessive oil canning, buckling, and tool marks.
  5. Install sealant tape where indicated.
  6. Torch cutting of flashing and sheet metal is not permitted.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
1. Coat back side of stainless-steel flashing and sheet metal with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
- D. Seal joints as shown and as required for watertight construction.
- E. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.
1. Do not solder metallic-coated steel and aluminum sheet.
  2. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
  3. Stainless-Steel Soldering: Tin edges of uncoated sheets using solder recommended for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
- 3.02 SHEET METAL FLASHING INSTALLATION
- A. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets spaced not more than 36 inches apart. Provide end closures and seal watertight with sealant. Slope to downspouts.
1. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet apart. Install expansion-joint caps.



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- B. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c. in between.
- C. Copings: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated.
  - 1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch centers.
  - 2. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.
- D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with sealant.

3.03 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as flashing and sheet metal are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION



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SECTION 07 65 00 - FLEXIBLE FLASHING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Self-adhering flexible flashing.
  - 2. Liquid-applied flexible flashing.
- B. Related Sections:
  - 1. Section 07 25 00 "Weather Barriers" for flexible flashings integral to weather barrier assemblies.
  - 2. Section 07 60 00 "Flashing and Sheet Metal" for sheet metal flashing.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation layouts of flashing, including plans, elevations, expansion-joint locations, and keyed details.
  - 1. Include details for forming, joining, supporting, and securing flashing, including termination points, expansion joints, edge conditions, special conditions, and connections to adjoining work.
  - 2. Include identification of material and thickness for each item.
- C. Samples: For each exposed product and for each finish specified.

1.03 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of flexible flashing product, for tests performed by a qualified testing agency.
- B. Maintenance data.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Flexible Flashing Performance, General: Flexible flashing seals with adjacent construction shall be capable of performing as a continuous air and water barrier. Flexible flashing shall be capable of accommodating substrate movement, construction material changes, penetrations, and transitions without deterioration, water penetration under pressure differential, and air leakage exceeding specified limits.

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- B. Self-Adhering Flexible Flashing Performance: Self-adhering flexible flashing shall meet minimum performance requirements when tested according to AAMA 711.

2.02 SELF-ADHERING FLEXIBLE FLASHING

- A. Self-Adhering Flexible Flashing: Cold-applied flashing tape, a minimum of 30 mils thick, consisting of a polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing, in factory cut widths.
1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. GCP Applied Technologies; Perm-A-Barrier Wall Flashing.
    - b. Henry; Blueskin TWF.
    - c. W.R. Meadows; Air-Shield Thru-Wall Flashing.
  2. Locations: Transition flashing at sheathing, metal flashings, and other locations indicated.
- B. High Temperature Self-Adhering Membrane Flashing: Cold-applied flashing tape, a minimum of 30 mils thick, consisting of a polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing, in factory cut widths.
1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Protecto Wrap: Sill Pan Flash Butyl.
    - b. Henry; FortiFlash Butyl Waterproof Flashing Membrane.
  2. Thermal Stability: Stable after testing at 240 deg F; ASTM D1970.
  3. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D1970.
  4. Locations:
    - a. Beneath metal copings.
    - b. Other locations indicated.
- C. Foil-Faced Self-Adhering Membrane Flashing: Cold-applied flashing tape, a minimum of 30 mils thick, consisting of a glass scrim reinforced aluminum foil laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing, in factory cut widths.
1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Henry; Metal Clad.
    - b. Polyguard; Aluma-Flash.
    - c. W.R. Meadows; Air-Shield Aluminum Flashing.
    - d. Karnak; 550 Patch-N-Go.
    - e. Soprema; Soprasolin HD.
    - f. GCP
  2. Locations:
    - a. Glazed framing assemblies.
    - b. Wall penetrations and wall openings.

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c. Other locations indicated.

D. Liquid Mastic: Liquid mastic recommended by flashing manufacturer.

## 2.03 LIQUID-APPLIED FLEXIBLE FLASHING

A. Multicomponent, Reinforced, Polymethyl Methacrylate (PMMA) Flashing:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Kemper System Kemperol AC Speed FR or comparable product by one of the following:
  - a. Soprema.
  - b. Siplast.
2. Membrane-Reinforcing Fabric: Manufacturer's recommended polyester fabric reinforcement.
3. Thickness: 90 mils, minimum.
4. Primer: As recommended by manufacturer for substrates indicated.
5. Finish Coat: Manufacturer's standard finish coat of type required and recommended for application over PMMA flashing membrane.
  - a. Color: As selected by Architect from manufacturer's full range.
6. Locations:
  - a. Door sills.
  - b. Rough openings.
  - c. Transitions at waterproofing membranes.
  - d. Other locations indicated.

## 2.04 MISCELLANEOUS MATERIALS

A. General: Provide materials required for complete flashing installation as recommended by manufacturer.

# PART 3 - EXECUTION

## 3.01 INSTALLATION, GENERAL

- A. General: Install flashing securely in place, with provisions for thermal and structural movement so that completed flashing shall not leak and shall remain watertight.
1. Install flashing and sheet metal true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
  2. Install flashing to fit substrates and conform to geometry of area receiving flashing resulting in watertight performance.

## 3.02 SELF-ADHERING FLEXIBLE FLASHING INSTALLATION

- A. Apply flexible flashing where indicated to comply with manufacturer's written instructions.
1. Clean, prepare, prime, and treat substrates according to manufacturer's written instructions.

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2. Lap seams and junctures with other materials at least 4 inches except that at flashing flanges of other construction, laps need not exceed flange width.
3. Apply in a shingled manner to shed water without interception by any exposed sheet edges.
4. Roll firmly to enhance adhesion to substrates.

3.03 LIQUID-APPLIED FLEXIBLE FLASHING INSTALLATION

- A. Apply flashing where indicated to comply with manufacturer's written instructions.
  1. Clean, prepare, prime, and treat substrates according to manufacturer's written instructions.
  2. Mix materials and apply flashing by roller, notched squeegee, trowel, or other suitable application method.
  3. Apply first coat of liquid-applied flashing, embed membrane-reinforcing fabric, and apply second coat of liquid-applied flashing to completely saturate reinforcing fabric and to obtain a seamless reinforced flashing membrane free of entrapped gases and pinholes, with an average dry film total thickness of 90 mils.
  4. Lap seams and junctures with other materials at least 4 inches except that at flashing flanges of other construction, laps need not exceed flange width.
  5. Apply masking tape to each side of joint, outside of area to be covered by flashing system.

3.04 CLEANING AND PROTECTION

- A. Protect flexible flashings from damage during application and remainder of construction period, according to manufacturer's written instructions.
  1. Protect flexible flashings from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace flexible flashing materials according to manufacturer's written instructions.
  2. Protect flexible flashings from contact with incompatible materials and sealants not approved by manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended in writing by manufacturer of affected construction.
- C. Remove masking materials after installation.

END OF SECTION



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SECTION 07 81 00 - APPLIED FIRE PROTECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Intumescent fire-resistive coatings.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
  - 2. Section 09 91 00 "Painting" for topcoats used over fire-resistive materials and coatings.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Framing plans or schedules, or both, indicating the following:
  - 1. Extent of fire protection for each construction and fire-resistance rating.
  - 2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
  - 3. Minimum applied fire protection thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
  - 4. Treatment of applied fire protection after application.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard dimensions in size.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for paints and coatings, indicating VOC content.
- B. Product Certificates: For each type of applied fire protection.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by applied fire protection manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.



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PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Paints and Coatings:
    - a. VOC content limits for field applications.

2.02 PERFORMANCE REQUIREMENTS

- A. Assemblies: Provide fire protection, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.
- B. Source Limitations: Obtain fire protection for each fire-resistance design from single source.
- C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Steel members are to be considered unrestrained unless specifically noted otherwise.
- D. Asbestos: Provide products containing no detectable asbestos.

2.03 INTUMESCENT FIRE-RESISTIVE COATINGS

- A. Fire-Resistive, Water-Based, Intumescent Coating:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Albi Manufacturing; a division of StanChem, Inc.; Albi Clad TF.
    - b. Carboline Company; a subsidiary of RPM International; AD Firefilm III.
    - c. Isolatek International; CAFCO SprayFilm-WB 4 and Cafco SprayFilm-WB 5.
  - 2. Application: Designated for "exterior" and "interior general purpose" use by a qualified testing agency acceptable to authorities having jurisdiction.
  - 3. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design.
  - 4. Surface-Burning Characteristics: In accordance with ASTM E84.
    - a. Flame-Spread Index: 25 or less.
    - b. Smoke-Developed Index: 50 or less.
  - 5. Finish: As selected by Architect from manufacturer's standard finishes.
    - a. Color and Gloss: As selected by Architect from manufacturer's full range.



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2.04 AUXILIARY MATERIALS

- A. Provide auxiliary materials that are compatible with fire protection and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. Substrate Primers: Primers approved by fire protection manufacturer and complying with one or both of the following requirements:
  - 1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
  - 2. Primer's bond strength in required fire-resistance design complies with specified bond strength for sprayed fire-resistive material and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E736.
- C. Topcoat: Suitable for application over applied fire protection; of type recommended in writing by fire protection manufacturer for each fire-resistance design.
  - 1. Water-Based Epoxy Topcoat: Water-based two-part high-performance epoxy sealer for brush, roller, or spray application over applied intumescent fire-resistive coating. Provide application at a rate of 120 sq. ft./gal. for a total dry film thickness of 14 mils in two or more coats.
    - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Isolatek International; CAFCO SprayFilm Topseal.
    - b. Locations: Provide at exterior intumescent coatings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design.
  - 1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fire protection with substrates under conditions of normal use or fire exposure.
  - 2. Verify that objects penetrating fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
  - 3. Verify that substrates receiving fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.

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- B. Conduct tests according to fire protection manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Cover other work subject to damage from fallout or overspray of fire protection materials during application.
- B. Prime substrates where included in fire-resistance design and where recommended in writing by fire protection manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.
- C. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fire protection. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.03 APPLICATION

- A. Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fire protection Work.
- B. Comply with applied fire protection manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- C. Coordinate application of fire protection with other construction to minimize need to cut or remove fire protection.
  - 1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
  - 2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.
- D. Install auxiliary materials as required, as detailed, and according to fire-resistance design and applied fire protection manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by applied fire protection manufacturer.



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- E. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by applied fire protection manufacturer.
- F. Extend fire protection in full thickness over entire area of each substrate to be protected.
- G. Install body of fire protection in a single course unless otherwise recommended in writing by applied fire protection manufacturer.
- H. Provide a uniform finish complying with description indicated for each type of fire protection material and matching finish approved for required mockups.
- I. Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.
- J. Finishes: Where indicated, apply fire protection to produce the following finishes:
  - 1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions for each finish selected.

3.04 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections.
- B. Fire protection will be considered defective if it does not pass tests and inspections.
  - 1. Remove and replace fire protection that does not pass tests and inspections, and retest.
  - 2. Apply additional fire protection, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

3.05 CLEANING

- A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

3.06 PROTECTION

- A. Protect fire protection, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fire protection is without damage or deterioration at time of Substantial Completion.

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APPLIED FIRE PROTECTION  
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3.07 REPAIRS

- A. As installation of other construction proceeds, inspect fire protection and repair damaged areas and fire protection removed due to work of other trades.
- B. Repair fire protection damaged by other work before concealing it with other construction.
- C. Repair fire protection by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION



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SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Penetration firestopping systems for the following applications:
    - a. Penetrations in fire-resistance-rated walls.
    - b. Penetrations in horizontal assemblies.
- B. Related Sections:
  - 1. Section 07 84 43 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
  - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.03 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.04 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance.



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1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.07 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. A/D Fire Protection Systems Inc.
  - 2. Grace Construction Products.
  - 3. Hilti, Inc.
  - 4. Johns Manville.
  - 5. Nelson Firestop Products.
  - 6. NUCO Inc.
  - 7. Passive Fire Protection Partners.
  - 8. RectorSeal Corporation.
  - 9. Specified Technologies Inc.
  - 10. 3M Fire Protection Products.
  - 11. Tremco, Inc.; Tremco Fire Protection Systems Group.
  - 12. USG Corporation.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
  - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.

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2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
  - a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
    - 1) UL in its "Fire Resistance Directory."
    - 2) Intertek Group in its "Directory of Listed Building Products."
    - 3) FM Approval in its "Approval Guide."

2.03 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
  1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
  1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
  2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
  1. Permanent forming/damming/backing materials.
  2. Substrate primers.
  3. Collars.
  4. Steel sleeves.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.02 PREPARATION

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
  - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
  - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.03 INSTALLATION

- A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
  - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
  - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
  - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.



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- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION



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SECTION 07 84 43 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Joints in or between fire-resistance-rated constructions.
- B. Related Sections:
  - 1. 078413 - Penetration Firestopping: For penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.
  - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.03 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each joint firestopping system, for tests performed by a qualified testing agency.

1.04 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.05 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.



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1.06 COORDINATION

- A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
  - 1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
  - 2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
    - a. Joint firestopping systems shall bear classification marking of a qualified testing agency.
      - 1) UL in its "Fire Resistance Directory."
      - 2) Intertek Group in its "Directory of Listed Building Products."

2.02 JOINT FIRESTOPPING SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.
  - 1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
- C. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.
- D. Accessories: Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.



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PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning: Before installing joint firestopping systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
  - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
  - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.03 INSTALLATION

- A. General: Install joint firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
  - 1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:
  - 1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
  - 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
  - 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

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3.04 CLEANING AND PROTECTION

- A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

END OF SECTION



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SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Sealant and backing materials.
  - 2. Acoustical sealants.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for sealants, indicating VOC content.
- B. Product Test Reports: For each kind of joint sealant.
- C. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
  - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
  - 2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
- D. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- E. Sample Warranties: For special warranties.

1.04 PRECONSTRUCTION TESTING

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

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1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with masonry substrates.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.

1.05 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
  2. When joint substrates are wet.
  3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.06 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period:
    - a. Silicone Sealants: 20 years from date of Substantial Completion.
    - b. All Other Sealants: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
1. Sealants:
    - a. VOC content limits for field applications.

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2.02 SOURCE LIMITATIONS

- A. Obtain joint sealants from single manufacturer for each sealant type.

2.03 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Nonstaining Joint Sealants: Where sealants are indicated to be nonstaining, provide products that exhibit no staining of substrates when tested according to ASTM C1248.
- C. Mildew-Resistant Joint Sealants: Where sealants are indicated to be mildew-resistant, provide products formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- D. Colors of Exposed Joint Sealants: Custom colors, as directed by Architect.

2.04 JOINT SEALANTS

- A. Silicone: Single-component, nonsag, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
  - 1. Joint Locations: Exterior joints in vertical surfaces and horizontal nontraffic surfaces, and as follows:
    - a. Control and expansion joints in unit masonry.
    - b. Joints between metal panels.
    - c. Joints between different materials listed above.
    - d. Perimeter joints between materials listed above and frames of doors, windows, glazed framing systems, and louvers.
    - e. Control and expansion joints in ceilings and other overhead surfaces.
    - f. Other joints as indicated on Drawings.
  - 2. Basis-of-Design Product: The Dow Chemical Company; DowSil 790, 791, or 795 at Contractor's option.
    - a. Subject to compliance with requirements, manufacturers offering comparable products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) GE Construction Sealants; Momentive Performance Materials Inc.
      - 2) Pecora Corporation.
      - 3) Sika Corporation; Joint Sealants.
      - 4) Tremco Incorporated.
- B. Silicone: Single-component, nonsag, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.



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1. Joint Locations: Sealant joints in contact with weather barrier, weather barrier flashing materials, and as follows:
    - a. Perimeter joints between materials listed above and frames of doors, windows, glazed framing systems, and louvers.
  2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
    - a. The Dow Chemical Company; DowSil 758 Silicone Weather Barrier Sealant.
    - b. Pecora Corporation; AVB Silicone.
- C. Silicone: Mildew-resistant, single-component, nonsag, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
1. Joint Locations: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces, and as follows:
    - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
    - b. Tile control and expansion joints in wet locations.
    - c. Other joints as indicated on Drawings.
  2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
    - a. GE Construction Sealants; Momentive Performance Materials Inc.; SCS1700 Sanitary.
    - b. The Dow Chemical Company; DowSil 786.
- D. Urethane: Multicomponent, nonsag, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T and NT.
1. Joint Locations: Interior joints in horizontal traffic surfaces, and as follows:
    - a. Isolation joints in cast-in-place concrete slabs.
    - b. Control and expansion joints in tile flooring.
    - c. Other joints as indicated on Drawings.
  2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
    - a. BASF Corporation; MasterSeal NP 2.
    - b. LymTal International Inc; Iso-Flex 881 or Iso-Flex 885 SG.
    - c. Pecora Corporation; Dynatred.
    - d. Sika Corporation; Joint Sealants; Sikaflex 2c NS TG.
- E. Urethane: Single-component, nonsag, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
1. Joint Locations: Interior joints in vertical surfaces and horizontal nontraffic surfaces, and as follows:
    - a. Control and expansion joints on exposed interior surfaces of exterior walls.
    - b. Tile control and expansion joints.
    - c. Vertical joints on exposed surfaces of unit masonry walls.
    - d. Other joints as indicated on Drawings.
  2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
    - a. Pecora Corporation; Dynatrol I-XL.

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- b. Polymeric Systems, Inc; Flexiprene 1000.
  - c. Sika Corporation; Joint Sealants; Sikaflex Textured Sealant.
  - d. Tremco Incorporated; Dymonic.
- F. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
- 1. Joint Locations: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement, and as follows:
    - a. Control joints on exposed interior surfaces of exterior walls.
    - b. Perimeter joints between interior wall surfaces and frames of interior doors glazed framing systems and elevator entrances.
    - c. Other joints as indicated on Drawings.
  - 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
    - a. BASF Corporation; MasterSeal NP 520.
    - b. Bostik, Inc.; Bosti-Flex Plus.
    - c. Pecora Corporation; AC-20.
    - d. Tremco Incorporated; Tremflex 834.
- G. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 or aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 in accordance with ASTM D2240.
- 1. Joint Locations: Interior, exposed sawcuts and non-moving control joints in concrete slabs.
  - 2. Color: As selected by Architect from manufacturer's full range.
  - 3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
    - a. BASF Corporation; MasterSeal CR 190.
    - b. Sika Corporation; Joint Sealants; Sikadur 51.

2.05 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834. Sealant effectively reduces airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E90.
- 1. Joint Location:
    - a. Acoustical joints where indicated.
    - b. Other joints as indicated.
  - 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
    - a. Accumetric LLC; BOSS 826 Acoustical Sound Sealant.
    - b. GE Construction Sealants; Momentive Performance Materials Inc.; RCS20 Acoustical.
    - c. Grabber Construction Products; Acoustical Sealant GSC.
    - d. Hilti, Inc.; CP 506 Smoke and Acoustical Sealant.
    - e. Pecora Corporation; AC-20 FTR or AIS-919.

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- f. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
  - g. Tremco Incorporated; Tremflex 834.
- B. Acoustical Sealant for Concealed Joints: Manufacturer's standard nonsag, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber acoustical sealant. Sealant effectively reduces airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E90
- 1. Joint Location:
    - a. Concealed acoustical joints where indicated.
    - b. Other joints as indicated.
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Pecora Corporation; BA-98.
    - b. Tremco Incorporated; Acoustical/Curtainwall Sealant.

2.06 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), unless otherwise recommended by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.07 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.
- D. Mineral Wool Forming Material: Unfaced mineral wool board insulation preformed or cut to fit metal deck flutes.
- E. Weep/Vent Tubes: Medium density polyethylene plastic tubing with integral insect screen.
  - 1. Size: 3/8 inch diameter by 4 inches long, unless indicated otherwise.

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2. Color: White.
3. Basis of Design Product: Hohmann & Barnard, Inc.; 341 Series Round Plastic Weep Holes.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
  1. Remove laitance and form-release agents from concrete.
  2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.02 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  1. Do not leave gaps between ends of sealant backings.
  2. Do not stretch, twist, puncture, or tear sealant backings.
  3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

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- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  - 1. Place sealants so they directly contact and fully wet joint substrates.
  - 2. Completely fill recesses in each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
  - 1. Remove excess sealant from surfaces adjacent to joints.
  - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  - 3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.
- G. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters including heads of walls, and through penetrations. Comply with ASTM C919, ASTM C1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.
- H. Two-Stage Joint System: Pressure equalized sealant system consisting of an exterior weather barrier sealant joint, an interior air barrier sealant joint, and weep/vent tubes.
  - 1. Install sealant and backer rod from the exterior.
  - 2. Install air barrier sealant and backer rod as indicated, but not less than 3 inches back from the face of the panel, with long nosed nozzle. Tool sealant to a uniform profile.
  - 3. Bridge air barrier sealant and weather sealant with backer rod and sealant sloped as indicated, but not less than 2 percent, to form a drainage path for water to exit the cavity. Insert weep/vent tube over the bridge sealant. Tool sealant carefully around weep/vent tubes for a watertight seal.
  - 4. Provide primary seal at the front side of panels using backer rod and Type S sealant.

3.03 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

END OF SECTION

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SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
  - 1. Standard hollow-metal doors and frames.

1.02 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.03 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.
- B. Shop Drawings: Include the following:
  - 1. Elevations of each door type.
  - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
  - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
  - 4. Locations of reinforcement and preparations for hardware.
  - 5. Details of each different wall opening condition.
  - 6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
  - 7. Details of anchorages, joints, field splices, and connections.
  - 8. Details of accessories.
  - 9. Details of moldings, removable stops, and glazing.

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- C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.05 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly and thermally rated door assemblies for tests performed by a qualified testing agency indicating compliance with performance requirements.
- B. Field quality control reports.

1.06 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
  - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Amweld International, LLC.
  - 2. Ceco Door Products; an Assa Abloy Group company.
  - 3. Curries Company; an Assa Abloy Group company.
  - 4. Deansteel.
  - 5. Fleming-Baron Door Products.
  - 6. Mesker Door Inc.
  - 7. Pioneer Industries, Inc.

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- 8. Security Metal Products Corp.
- 9. Steelcraft; an Ingersoll-Rand company.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.
- B. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.70 Btu/sq. ft. x h x deg F when tested according to ASTM C518.

2.03 INTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. .
  - 1. Doors:
    - a. Type: As indicated in the Door and Frame Schedule.
    - b. Thickness: 1-3/4 inches.
    - c. Face: Uncoated steel sheet, minimum thickness of 0.053 inch.
    - d. Edge Construction: Model 2, Seamless.
    - e. Core: Manufacturer's standard .
    - f. Fire-Rated Core: Manufacturer's standard core for fire-rated doors.
  - 2. Frames:
    - a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
    - b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
    - c. Construction: Face welded.
  - 3. Exposed Finish: Prime.

2.04 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. .
  - 1. Doors:
    - a. Type: As indicated in the Door and Frame Schedule.
    - b. Thickness: 1-3/4 inches.

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- c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
- d. Edge Construction: Model 2, Seamless.
- e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
- f. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
- g. Core: Manufacturer's standard .
- 2. Frames:
  - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
  - b. Construction: Full profile welded.
- 3. Exposed Finish: Prime.

2.05 FRAME ANCHORS

- A. Jamb Anchors:
  - 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
  - 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
  - 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
  - 1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.06 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

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- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
- G. Glazing: Comply with requirements in Section 08 81 00 "Glass Glazing."

2.07 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
  - 1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
  - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
  - 3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
    - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
  - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
  - 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

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- D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted hairline joints.
1. Provide stops and moldings flush with face of door, and with square stops unless otherwise indicated.
  2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
  3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
  4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
  5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.08 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.02 INSTALLATION

- A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.
1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

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- a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
      - b. Install frames with removable stops located on secure side of opening.
    - 2. Fire-Rated Openings: Install frames according to NFPA 80.
    - 3. Floor Anchors: Secure with postinstalled expansion anchors.
      - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
    - 4. Solidly pack mineral-fiber insulation inside frames.
    - 5. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
      - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
      - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
      - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
      - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
  - C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
    - 1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
    - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
  - D. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow-metal manufacturer's written instructions.
- 3.03 FIELD QUALITY CONTROL
- A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.
  - B. Inspections:
    - 1. Fire-Rated Door Inspections: Inspect each fire-rated door according to NFPA 80, Section 5.2.
  - C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
  - D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
  - E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80.

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3.04 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION

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SECTION 08 12 16.13 - FIRE-RATED ALUMINUM FRAMES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Fire-rated interior aluminum frames and glazing.
  - 2. Fire-rated interior aluminum doors and glazing.

1.02 SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, fire-resistance rating, and finishes.
- B. Shop Drawings: For fire-rated aluminum frames:
  - 1. Include elevations, sections, and installation details for each wall-opening condition.
  - 2. Include details for each frame type, including dimensioned profiles and metal thicknesses.
  - 3. Include locations of reinforcements and preparations for hardware.
  - 4. Include details of anchorages, joints, field splices, connections, and accessories.
  - 5. Include details of moldings, removable stops, and glazing.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard sizes.
- D. Maintenance Data: For aluminum frames to include in maintenance manuals.

1.03 QUALITY ASSURANCE

- A. Fire Resistive Wall and Door Assemblies: Tested in accordance with ASTM E119, NFPA 251, UL 263 and ULC-S101.
- B. Fire Protective Door Assemblies: Tested in accordance with NFPA 80, NFPA 252, ASTM E152, ASTM E2074, UL 10B, UL 10C and CAN4-S104.
- C. Listings and Labels:
  - 1. Fire rated framing system shall be under current follow-up service by a nationally recognized independent laboratory approved by OSHA and maintain a current listing or certification. Assemblies shall be labeled in accordance with limits of listings.

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1.04 PROJECT CONDITIONS

- A. Obtain field measurements prior to fabrication of frame units. If field measurements will not be available in a timely manner coordinate planned measurements with the work of other sections. Note whether field or planned dimensions were used in the creation of the shop drawings.
- B. Coordinate the work of this section with others effected including but not limited to: other interior components and door hardware beyond that provided by this section.

1.05 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors and frames that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Technical Glass Products (TGP); Fireframes Aluminum Series or comparable product by one of the following:
  - 1. Saftifirst.
- B. Source Limitations: Obtain aluminum frames, fire-rated glazing, and frame-manufacturer's doors from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Frames: Frames for fire-rated door assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
  - 1. Frames for Smoke- and Draft-Control Assemblies: Tested according to UL 1784 and installed in compliance with NFPA 105.
    - a. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg.

2.03 COMPONENTS

- A. Framing: Manufacturer's standard, factory-assembled, steel framed, aluminum-clad construction.
  - 1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
  - 2. Cold-Rolled Sheet and Strip: ASTM A 611.
  - 3. Hot-Rolled Sheet and Strip: ASTM A 570/A 570M.

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- B. Aluminum Cladding and Trim: ASTM B 221, with alloy and temper required to suit structural and finish requirements, and not less than 0.062 inch thick.
- C. Doors: Manufacturer's standard, factory-assembled, 1-3/4-inch- thick, steel framed, aluminum-clad door construction.
- D. Aluminum Finish: Clear-anodized aluminum .

2.04 GLAZING

- A. Fire Rated Glazing: Composed of multiple sheets of ultraclear, high visible light transmission glass laminated with an intumescent interlayer.
  - 1. Basis-of-Design Product: Pilkington Pyrostop.
  - 2. Fire Rating: 60.
- B. Labeling: Each piece of fire-rated glazing shall be labeled with a permanent logo including name of product, manufacture, testing laboratory (UL), fire rating period, safety glazing standards, and date of manufacture.

2.05 ACCESSORIES

- A. Fasteners: Aluminum, nonmagnetic, stainless-steel or other noncorrosive metal fasteners compatible with frames, stops, panels, reinforcement plates, hardware, anchors, and other items being fastened.
- B. Door Silencers: Manufacturer's standard continuous mohair, wool pile, or vinyl seals in black color.
- C. Smoke Seals: Intumescent strip or fire-rated gaskets in black.
- D. Glazing Gaskets: Manufacturer's standard extruded or molded rubber or plastic, to accommodate glazing thickness indicated; in black.
- E. Door Hardware: As specified in Section 08 71 00 "Door Hardware."
- F. Intumescent Caulk: Single component, latex-based, intumescent caulk designed to stop passage of fire, smoke, and fumes through fire-rated separations; permanently flexible after cure; will not support mold growth; flame spread/smoke developed 10/10.
- G. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Board Insulation: ASTM C 612, maximum flame-spread and smoke-developed indexes of 15 and 0, respectively; passing ASTM E 136 for combustion characteristics; and of the following nominal density and thermal resistivity:
  - 1. Nominal density of 4 lb/cu. ft., Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F.



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2.06 FABRICATION

- A. Provide concealed corner reinforcements and alignment clips for accurately fitted hairline joints at butted and mitered connections.
- B. Factory prepare aluminum frames to receive templated mortised hardware; include cutouts, reinforcements, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Section 08 71 00 "Door Hardware."
  - 1. Locate hardware cutouts and reinforcements as required by fire-rated label for assembly.
- C. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.
  - 1. Locate removable stops on the inside of spaces accessed by keyed doors.
- D. Fabricate components to allow secure installation without exposed fasteners.

2.07 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.08 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that wall thickness does not exceed standard tolerances allowed by throat size of indicated aluminum frame.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install aluminum frames plumb, rigid, properly aligned, and securely fastened in place; according to manufacturer's written instructions.

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1. At fire-protection-rated openings, install fire-rated frames according to NFPA 80 and NFPA 105.
  - B. Install frame components in the longest possible lengths with no piece less than 48 inches; components 96 inches or shorter shall be one piece.
    1. Fasten to suspended ceiling grid on maximum 48-inch centers, using sheet metal screws or other fasteners approved by frame manufacturer.
    2. Use concealed installation clips to produce tightly fitted and aligned splices and connections.
    3. Secure clips to extruded main-frame components and not to snap-in or trim members.
    4. Do not leave screws or other fasteners exposed to view when installation is complete.
  - C. Glass: Install glass according to Section 08 81 00 "Glass Glazing" and aluminum-frame manufacturer's written instructions.
  - D. Doors: Install doors aligned with frames and fitted with required hardware.
  - E. Door Hardware: Install according to Section 08 71 00 "Door Hardware" and aluminum-frame manufacturer's written instructions.
- 3.03 ADJUSTING
- A. Inspect installation, correct misalignments, and tighten loose connections.
  - B. Doors: Adjust doors to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly, and lubricate as recommended by manufacturer.
  - C. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended in writing by frame manufacturer and according to AAMA 609 & 610.
  - D. Touch Up: Repair marred frame surfaces to blend inconspicuously with adjacent unrepared surface so touchup is not visible from a distance of 48 inches as viewed by Architect. Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

END OF SECTION



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SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Solid-core flush wood doors with wood-veneer faces.
  - 2. Factory finishing flush wood doors.
  - 3. Factory fitting flush wood doors to frames and factory machining for hardware.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
  - 1. Door core materials and construction.
  - 2. Door edge construction
  - 3. Door face type and characteristics.
  - 4. Door louvers.
  - 5. Door trim for openings.
  - 6. Factory-machining criteria.
  - 7. Factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
  - 1. Door schedule indicating door location, type, size, fire protection rating, and swing.
  - 2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
  - 3. Details of frame for each frame type, including dimensions and profile.
  - 4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
  - 5. Dimensions and locations of blocking for hardware attachment.
  - 6. Dimensions and locations of mortises and holes for hardware.
  - 7. Clearances and undercuts.
  - 8. Requirements for veneer matching.
  - 9. Doors to be factory finished and application requirements.
- C. Samples for Initial Selection: For factory-finished doors.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:

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1. Documentation for composite wood products, indicating compliance with emissions testing or certification.
  - B. Field quality-control reports.
  - C. Sample Warranty: For special warranty.
- 1.04 QUALITY ASSURANCE
- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies shall comply with qualifications set forth in NFPA 80, Section 5.2.3.1.
- 1.05 DELIVERY, STORAGE, AND HANDLING
- A. Comply with requirements of referenced standard and manufacturer's written instructions.
  - B. Mark each door on bottom rail with opening number used on Shop Drawings.
- 1.06 FIELD CONDITIONS
- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of construction period.
- 1.07 WARRANTY
- A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
    1. Failures include, but are not limited to, the following:
      - a. Delamination of veneer.
      - b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
      - c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
    2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
    3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Flush Wood Door Manufacturers: Subject to compliance with requirements, unless indicated otherwise, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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1. Algoma Hardwoods, Inc.
2. Eggers Industries.
3. Graham; an Assa Abloy Group company.
4. Marshfield Door Systems, Inc.
5. Mohawk Flush Doors, Inc.; a Masonite company.
6. Oshkosh Architectural Door Company.
7. Poncraft Door Company.
8. Vancouver Door Company.
9. VT Industries Inc.

2.02 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
1. Composite Wood Products:
    - a. Formaldehyde emissions testing or certification.

2.03 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI/AWMAC/WI's "Architectural Woodwork Standards."
1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.

2.04 VENEERED-FACED FLUSH WOOD DOORS FOR TRANSPARENT FINISH

- A. Interior Doors:
1. Performance Grade:
    - a. ANSI/WDMA I.S. 1A Heavy Duty unless otherwise indicated on Drawings.
    - b. ANSI/WDMA I.S. 1A Extra Heavy Duty: Public toilets, janitor's closets, assembly spaces, exits, and where indicated on Drawings.
    - c. ANSI/WDMA I.S. 1A Standard Duty: Closets (not including janitor's closets) and where indicated on Drawings.
  2. Architectural Woodwork Standards Grade: Custom.
  3. Faces: Single-ply wood veneer not less than 1/50 inch thick.
    - a. Species and Cut: As indicated on Drawings.
    - b. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
  4. Core for Non-Fire-Rated Doors:
    - a. ANSI A208.1, Grade LD-1 or Grade LD-2 particleboard.
      - 1) Provide doors with glued-wood-stave or WDMA I.S. 10 structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in Section 08 71 00 "Door Hardware."
  5. Construction: Five or seven plies, stiles and rails bonded to core, with entire unit abrasive planed before veneering.

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2.05 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated.
  - 1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
- B. Factory machine doors for hardware that is not surface applied.
  - 1. Locate hardware to comply with DHI-WDHS-3.
  - 2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
  - 3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
  - 4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
  - 5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

2.06 FACTORY FINISHING

- A. Comply with referenced quality standard for factory finishing.
  - 1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
  - 2. Finish faces, all four edges, edges of cutouts, and mortises.
  - 3. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Transparent Finish:
  - 1. Architectural Woodwork Standards Grade: Premium.
  - 2. Finish: Architectural Woodwork Standards System-9, UV Curable, Acrylated Epoxy, Polyester or Urethane.
  - 3. Sheen: Satin.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
  - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
  - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.02 INSTALLATION

- A. Hardware: For installation, see Section 08 71 00 "Door Hardware."
- B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
- C. Job-Fitted Doors:
  - 1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
    - a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
  - 2. Machine doors for hardware.
  - 3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
  - 4. Clearances:
    - a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
    - b. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
    - c. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
  - 5. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
- D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.03 FIELD QUALITY CONTROL

- A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
  - 1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80.



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3.04 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION



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SECTION 08 35 13.13 - MULTIPANEL FOLDING ALUMINUM-FRAMED GLASS DOORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Multipanel folding aluminum-framed glass doors.
- B. Related Sections:
  - 1. 084400 - Curtain Wall and Glazed Assemblies: For coordinating finish among aluminum fenestration units on the building exterior.
  - 2. Section 08 71 00 "Door Hardware" for hardware not specified in this Section.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for multipanel folding aluminum-framed glass doors.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and installation details.
  - 2. Indicate dimensions, configuration of panels, and stacking layout.
- C. Samples: For each multipanel folding aluminum-framed glass door and for each color specified, 12-inch-long section with factory-applied color finish.

1.03 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each multipanel folding aluminum-framed glass door, for tests performed by a qualified testing agency; and for each class and performance grade indicated, tested at AAMA gateway size.
- B. Sample Warranty: For manufacturer's special warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data:
  - 1. For multipanel folding aluminum-framed glass doors to include in maintenance manuals. Include finishes, weather stripping, operable panels, and operating hardware.

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1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating multipanel folding aluminum-framed glass doors that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations.
- B. Installer Qualifications: An installer acceptable to multipanel folding aluminum-framed glass door manufacturer for installation of units required for this Project.

1.06 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace multipanel folding aluminum-framed glass doors that fail(s) in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure to meet performance requirements.
    - b. Structural failures, including excess deflection.
    - c. Excessive water leakage or air infiltration.
    - d. Faulty operation of movable panels and hardware.
    - e. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
    - f. Failure of insulating glass.
  - 2. Warranty Period:
    - a. Multipanel Folding Aluminum-Framed Glass Doors: 10 year(s) from date of Substantial Completion.
    - b. Insulating-Glass Units: 10 years from date of Substantial Completion.
- B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Warranty Period: 10 years from date of Substantial Completion.

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PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide folding aluminum-framed glass doors Model SL70 manufactured by Nana Wall or comparable product by one of the following:
1. Arcadia, Inc.
  2. Solar Innovations.

2.02 PERFORMANCE REQUIREMENTS

- A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
1. Product Certification: AAMA certified with label attached to each door.
- B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
1. Minimum Performance Class: As indicated on Drawings.
  2. Minimum Performance Grade: As indicated on Drawings.
- C. Thermal Transmittance: NFRC 100 maximum total fenestration product U-factor as indicated on Drawings.
- D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum total fenestration product SHGC as indicated on Drawings.
- E. Thermal Movements: Provide multipanel folding aluminum-framed glass doors, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.03 MULTIPANEL FOLDING ALUMINUM-FRAMED GLASS DOORS

- A. Multipanel Folding Aluminum-Framed Glass Doors: Provide extruded-aluminum-framed multipanel folding glass doors, complete with glazing, threshold, flashings, support, and anchorage devices.
1. Stack Storage Configuration: As shown on Drawings.
- B. Frames and Door Panels: Fabricated from aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440. Provide factory-assembled door panels that are reglazable without dismantling panel framing, and factory-assembled frames.

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1. Thermally Improved Construction: Fabricate frames and door panels with an integral, concealed, low-conductance thermal barrier located between exterior and interior surfaces in a manner that eliminates direct metal-to-metal contact.
2. Door Panel Design: As indicated design.

2.04 GLAZING

- A. Glass and Glazing: Manufacturer's standard glazing system that produces weathertight seal. Comply with requirements indicated in Section 08 80 00 "Glazing".

2.05 HARDWARE

- A. Provide manufacturer's standard hardware, fabricated from a corrosion-resistant material compatible with door panels and other components, and complying with AAMA 907. Provide hardware designed to smoothly operate, tightly close, and securely lock multipanel folding aluminum-framed glass doors. Size hardware to accommodate panel weights and dimensions. Provide full-perimeter weatherstripping for each door panel.
- B. Panel Support System: Provide panel support system designed for size, weight, and performance requirements of multipanel folding aluminum-framed glass doors indicated. Provide carriers with sealed ball bearings.
  1. Bottom Supported: Provide carrier system designed to roll on track within threshold, with overhead wheeled guide that engages upper track.
  2. Adjustment: Provide panel support system capable of being adjusted for smooth operation and clearances without needing to remove panels from tracks.
  3. Threshold Configuration: Extruded-aluminum, thermally broken, threshold with low profile, compliant with United States Access Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines" with concealed drainage system.
- C. Panel Hinges: Stainless steel, multileaf hinge with painted finish to match exterior. Provide integral hangers and guides for hinges that engage panel support system.

2.06 ACCESSORIES

- A. Trim: Provide interior and exterior casings, jamb extensions, and other components in material and finish to match door frames.
- B. Fasteners: Noncorrosive and compatible with door members, trim, hardware, anchors, and other components.
  1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

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- C. Anchors, Clips, and Accessories: Provide anchors, clips, and accessories of aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron for multipanel folding aluminum-framed glass doors, complying with ASTM B456 or ASTM B633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

2.07 FABRICATION

- A. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.
- B. Factory-Glazed Fabrication: Glaze sliding aluminum-framed glass doors in the factory.

2.08 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.09 ALUMINUM FINISHES

- A. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.
  - 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions .
  - 2. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of Work.
- B. Verify rough opening dimensions, levelness of threshold substrate, and operational clearances.
- C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight hinged-door installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.02 INSTALLATION

- A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing multipanel folding aluminum-framed glass doors, hardware, accessories, and other components.
- B. Install multipanel folding aluminum-framed glass doors level, plumb, square, true to line; without distortion, warp, or rack of frames and panels, and without impeding thermal movement; anchored securely in place to structural support; and in proper relation to wall flashing, vapor retarders, air barriers, water/weather barriers, and other adjacent construction.
- C. Set threshold members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.
- D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.03 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
  - 1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
- B. Multipanel folding aluminum-framed glass door will be considered defective if it does not pass tests and inspections.

3.04 ADJUSTING

- A. Adjust hardware for proper alignment, smooth operation, and proper latching without unnecessary force or excessive clearance.
- B. Adjust hardware and operable panels to function smoothly, and lubricate as recommended by manufacturer.

3.05 CLEANING

- A. Clean exposed surfaces immediately after installation. Avoid damaging protective coatings and finishes. Remove nonpermanent labels, excess sealants, glazing materials, dirt, and other substances.
- B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

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3.06 PROTECTION

- A. Protect multipanel folding aluminum-framed glass door surfaces from contact with contaminating substances resulting from construction operations. Remove contaminants immediately according to manufacturer's written instructions.
- B. Refinish or replace folding aluminum-framed glass doors with damaged finishes.

END OF SECTION

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SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Exterior storefront framing.
  - 2. Exterior manual-swing entrance doors and door-frame units.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include plans, elevations, sections, full-size details, and attachments to other work.
  - 1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- C. Samples: For each exposed finish required.

1.03 INFORMATIONAL SUBMITTALS

- A. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams.
- B. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.
- D. Product test reports.
- E. Sample warranties.
- F. Maintenance data.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

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- B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated .
- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
  - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.05 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated, or comparable products by one of the following:
  - 1. Arcadia, Inc.
  - 2. Kawneer North America.
  - 3. Oldcastle Building Envelope.
  - 4. YKK AP America Inc.
- B. Source Limitations: Obtain all components of aluminum-framed entrances and storefront, including framing and accessories, from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design aluminum-framed entrances and storefronts.

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- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
  2. Failure also includes the following:
    - a. Thermal stresses transferring to building structure.
    - b. Glass breakage.
    - c. Noise or vibration created by wind and thermal and structural movements.
    - d. Loosening or weakening of fasteners, attachments, and other components.
    - e. Failure of operating units.
- C. Structural Loads:
1. Wind Loads: As indicated on Drawings.
  2. Other Design Loads: As indicated on Drawings.
- D. Deflection of Framing Members: At design wind pressure, as follows:
1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
  2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
- E. Structural: Test according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
  2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
  3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Area:
    - a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
  2. Entrance Doors:

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- a. Pair of Doors: Maximum air leakage of 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
  - b. Single Doors: Maximum air leakage of 0.5 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
  - 1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 8 lbf/sq. ft..
- H. Energy Performance: Certify and label energy performance according to NFRC as follows:
  - 1. Thermal Transmittance (U-factor):
    - a. Fixed glazing and framing areas shall have U-factor of not more than value indicated on Drawings as determined according to NFRC 100.
  - 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than value indicated on Drawings as determined according to NFRC 200.
- I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.03 FRAMING

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
  - 1. Basis-of-Design Product: Arcadia, Inc.; AFG601T.
  - 2. Construction: Thermally broken.
  - 3. Glazing System: Retained mechanically with gaskets on four sides.
  - 4. Finish: High-performance organic finish.
  - 5. Fabrication Method: Field-fabricated stick system.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Materials:
  - 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
    - a. Sheet and Plate: ASTM B 209.
    - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
    - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
    - d. Structural Profiles: ASTM B 308/B 308M.

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2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
  - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
  - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
  - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.04 THERMAL ENTRANCE DOOR SYSTEMS

- A. Thermal Entrance Doors: Manufacturer's high-performance thermal glazed entrance doors for manual-swing operation.
  1. Basis-of-Design Product: Arcadia, Inc.; NS212 Standard Narrow Stile.
  2. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
  3. Door Design: As indicated.
  4. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.

2.05 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 08 71 00 "Door Hardware."

2.06 GLAZING

- A. Glazing: Comply with Section 088100 "Glass Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.

2.07 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
  1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
  2. Reinforce members as required to receive fastener threads.
- B. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

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- C. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.

2.08 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
  - 1. Profiles that are sharp, straight, and free of defects or deformations.
  - 2. Accurately fitted joints with ends coped or mitered.
  - 3. Physical and thermal isolation of glazing from framing members.
  - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  - 5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
- F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
- G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.09 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.
  - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

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PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Seal perimeter and other joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Set continuous sill members and flashing in full sealant bed as specified in Section 07 92 00 "Joint Sealants" to produce weathertight installation.

D. Install components plumb and true in alignment with established lines and grades.

E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

F. Install glazing as specified in Section 08 81 00 "Glass Glazing."

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.02 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.

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1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
  - a. Perform a minimum of two tests in areas as directed by Architect.
- C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.

END OF SECTION

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SECTION 08 44 00 - CURTAIN WALL AND GLAZED ASSEMBLIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Structural sealant glazed aluminum curtain walls.
  - 2. Interior aluminum closures, caps, trim, and sill extensions.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
  - 2. Section 07 92 00 "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.
  - 3. Section 08 91 19 "Fixed Louvers" for units installed with glazed framing systems.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Scale elevations and sections in as large a scale as practical. Include full-scale sections when directed by Architect.
  - 2. When directed by Architect, Include full-size isometric details of each type of vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
    - a. Joinery, including concealed welds.
    - b. Anchorage.
    - c. Expansion provisions.
    - d. Glazing.
    - e. Flashing and drainage.
  - 3. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
  - 4. Provide references to detail numbers shown on drawings and references to specification sections, Article, and paragraph numbers to identify material types and finishes.
  - 5. Provide details showing connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
    - a. Indicate the plane of primary air and water resistance of both the air / water barrier system and the curtain wall system to which it connects.
- C. Samples: For each type of exposed finish required.

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1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for sealants, indicating VOC content.
- B. Delegated-Design Submittal: For glazed aluminum curtain walls and curtain wall mockups, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Energy Performance Certificates: NFRC-certified energy performance values for each glazed aluminum curtain wall.
- D. Product Test Reports: For glazed aluminum curtain walls, for tests performed by a qualified testing agency.
- E. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C1401. Include periodic quality-control reports.
- F. Sample Warranties: For special warranties.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.
- B. Maintenance Data for Structural Sealant: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
  - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

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- C. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of curtain wall assemblies.
- D. Architect, Owner, and their authorized agents shall be provided full access to plant, shop (excluding paint facility), and assembly point to view and inspect the processes and methods employed in the fabrication, assembly, and finishing of the curtain wall.

1.06 PRECONSTRUCTION LABORATORY MOCKUPS

- A. Preconstruction Adhesion and Compatibility Testing: Submit to structural glazing sealant manufacturer, for testing indicated below, Samples of each glazing material type, spandrel panel type, tape sealant, gasket, glazing accessory, and framing member that is in close proximity to or is touching the structural or nonstructural sealants of a structural glazed system.
  - 1. Compatibility: Test materials or components using ASTM C1087.
  - 2. Adhesion: Test for adhesion or lack of adhesion of a structural sealant to the surface of another material or component using ASTM C1135.
  - 3. Submit no fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
  - 4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
  - 5. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
  - 6. Testing will not be required if data based on previous testing of current sealant products match those submitted.

1.07 WARRANTY

- A. Special Assembly Warranty: Manufacturer's or installer's standard form in which manufacturer or installer agrees to repair or replace components of glazed aluminum curtain wall systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period. The warranty shall state that the exterior curtain wall system is not defective in workmanship or materials and conforms to the final approved Shop Drawings except for reasonable variances not impairing the usefulness of the wall system. The warranty shall apply to both patent and latent defects but does not include ordinary wear and tear, or unusual abuse or neglect, or the acts of omissions of parties other than the curtain wall contractor.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure to meet specified performance requirements.
    - b. Structural failures including, but not limited to, excessive deflection.
    - c. Noise or vibration caused by thermal movements.
    - d. Deterioration of metals and other materials beyond normal weathering.
    - e. Water leakage.
    - f. Failure of operating components to function normally.

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2. Warranty Period: Five years from date of Substantial Completion.

- B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Basis-of-Design Assembly: Subject to compliance with requirements, provide Arcadia, Inc.; T500-OPG1900 System, or comparable product by one of the following:
1. Arcadia, Inc.
  2. EFCO Corporation.
  3. Kawneer North America, an Arconic company.
  4. Oldcastle, Inc.
  5. Shuco USA LP.
  6. Waltek & Company Limited.
  7. Wausau Window and Wall Systems.
  8. YKK AP America Inc.
- B. Source Limitations: Unless indicated otherwise, obtain all components of glazed framing systems, including framing, spandrel panels, snap-on mullion components, interior trim, window sills and stools, and accessories, from single manufacturer.

### 2.02 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
1. Sealants:
    - a. VOC content limits for field applications.

### 2.03 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazed aluminum curtain walls and mockup support assemblies.
- B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

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1. Glazed aluminum curtain walls shall withstand movements of supporting structure, including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
  2. Failure also includes the following:
    - a. Thermal stresses transferring to building structure.
    - b. Glass breakage.
    - c. Noise or vibration created by wind and thermal and structural movements.
    - d. Loosening or weakening of fasteners, attachments, and other components.
    - e. Failure of operating units.
- C. Structural Loads:
1. Wind-Load Design Pressure: As indicated on Drawings and in accordance with ASCE/SEI 7.
  2. Periodic Maintenance-Equipment Loads:
    - a. Intermittent Stabilization Anchors: 600 lbs force perpendicular to framing, horizontal in both directions, and vertical in both directions with no damage, decrease in performance, or permanent deformation of framing members.
- D. Air Barrier Interfaces: Designed to withstand the same wind load as the air barrier system(s) to which they attach.
- E. Deflection of Framing Members: At design wind pressure, as follows:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches, and to 1/240 of clear span plus 1/4 inch, for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
  2. Deflection Parallel to Glazing Plane: Limited to an amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
  3. Cantilever Deflection: Where framing members overhang an anchor point, limited to 2 times the length of cantilevered member, divided by 175.
- F. Structural: Test according to ASTM E330/E330M as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
  2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
  3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- G. Air Infiltration: Test according to ASTM E283 for infiltration as follows:
1. Fixed Framing and Glass Area:

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- a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft..
- H. Water Penetration under Static Pressure: Test according to ASTM E331 as follows:
  - 1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft..
- I. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
  - 1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft..
  - 2. Maximum Water Leakage: Defined as the appearance of any water on the interior side of any part of the glazed wall assembly, including the interface locations with adjacent envelope systems, that is not contained and drained back to the exterior, or that can cause damage to adjacent materials or finishes. Water fully contained in drained flashings, gutters, and sills is not considered water penetration. Water that penetrates past the plane of the primary air/water barrier of the curtain wall system shall be considered as water leakage, unless the water is contained within the curtain wall system and is provided a means to drain back to the exterior.
- J. Interstory Drift: Accommodate design displacement of adjacent stories indicated.
  - 1. Test Performance: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.4 at elastic and inelastic displacement.
- K. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 or by engineering analysis at design displacement.
- L. Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.7 at design displacement.
- M. Energy Performance; Vision Areas: Certify and label energy performance according to NFRC as follows:
  - 1. Thermal Transmittance (U-factor): Fixed glazing and framing areas as a system shall have U-factor of not more than value indicated on Drawings as determined according to NFRC 100.
  - 2. SHGC: Fixed glazing and framing areas as a system shall have a SHGC of no greater than value indicated on Drawings as determined according to NFRC 200.
- N. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

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1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

- O. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by curtain wall systems without failing adhesively or cohesively. Provide sealant that fails cohesively before sealant releases from substrate when tested for adhesive compatibility with each substrate and joint condition required.
1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
  2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.04 GLAZED ALUMINUM CURTAIN WALL SYSTEMS

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
- B. Glazing System : Structurally silicone glazed and as follows:
1. Aluminum Finishes:
    - a. Surfaces Exposed to Weather: High-performance organic finish.
    - b. Interior Surfaces: High-performance organic finish.
  2. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
  3. Steel Reinforcement: As required by manufacturer.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.05 GLAZING

- A. Glazing: Comply with Section 08 81 00 "Glass Glazing."
- B. Glazing Sealants: As recommended by manufacturer.

2.06 ENTRANCES

- A. Entrances: Comply with Division 08 Section "Aluminum-Framed Entrances and Storefronts."

2.07 SUN CONTROL

- A. Sunshades: Assemblies consisting of manufacturer's standard outrigger brackets, louvers, and fascia, designed for attachment to curtain wall with mechanical fasteners.
1. Basis-of-Design Product: Arcadia, Inc.; BSS012.
  2. Orientation: As indicated on Drawings.
  3. Projection from Wall: As indicated on Drawings.

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4. Finish: Match adjacent glazed framing system.

B. Materials:

1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
  - a. Sheet and Plate: ASTM B 209.
  - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
  - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
  - d. Structural Profiles: ASTM B 308/B 308M.

2.08 MATERIALS

A. Sheet and Plate: ASTM B209.

B. Metallic Coated Steel Sheet:

1. One of the following:
  - a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
  - b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; structural quality.

C. Stainless Steel: Shall conform to American Iron and Steel Institute's "Steel Products Manual" and the following:

1. Tubing: ASTM A268 or A269.
2. Hot-Finished and Cold Finished Bars and Shapes: ASTM A276.
3. Plate, Sheet and Strip: ASTM A167, A176, or A666
4. Hot-Rolled and Cold-Rolled Sheet and Strip: ASTM A606.

D. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated, complying with requirements of the standards indicated below.

1. Sheet and Plate: ASTM B209.
2. Extruded Bars, Rods, Shapes and Tubes: ASTM B221.
3. Bars, Rods, and Wires: ASTM B211.
4. Standard Structural Shapes: ASTM B308.
5. Sand Casting: ASTM B26.
6. Permanent Mold Castings: ASTM B108.
7. Drawn Seamless Tube: ASTM B210.
8. Extruded Structural Pipe and Tubes: ASTM B429.
9. Die Castings: ASTM B85.

E. Structural Profiles: ASTM B308/B308M.

F. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

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- G. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
- H. Fasteners:
  - 1. Fasteners used to join aluminum to aluminum shall be aluminum or stainless steel.
  - 2. Fasteners used to join stainless steel to stainless steel shall be stainless steel.
  - 3. Exposed fasteners to match finish of curtain wall system.

2.09 SEALANTS

- A. Sealant For Structural Glazing, One Component: Shop/Factory or Site Installed. ASTM C 1184, neutral-curing silicone formulation compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in curtain-wall systems indicated.
  - 1. Available Products:
    - a. Dowsil.: Dow Corning 795 or 995.
    - b. Momentive Performance Products.: GE UltraGlaze SSG4000 or SilPruf SCS2000.
    - c. Tremco Inc.: Proglaze SSG.
- B. Sealant For Structural Glazing, Two Component: Shop/Factory or Site Installed. ASTM C 1184, neutral-curing silicone formulation compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in curtain-wall systems indicated.
  - 1. Available Products:
    - a. Dowsil.: Dow Corning 983.
    - b. Momentive Performance Products.: GE UltraGlaze SSG4600.
    - c. Tremco Inc.: Proglaze II.
- C. Primer: Nonstaining type, recommended by sealant manufacturer to suit application.
- D. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer; compatible with joint forming materials and not damaging to exposed surfaces.
- E. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

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2.10 ACCESSORY MATERIALS

- A. Aluminum Trim: Aluminum sheet meeting ASTM B 209 requirements for alloy and temper recommended by manufacturer and finisher, and with not less than strength and durability properties of Alloy 5005-H32. Form trim components from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.
  - 1. Thickness: As required to meet performance requirements, but not less than 0.063 inch.
  - 2. Finish: Match framing, unless otherwise indicated.
- B. Anchors: Adjustable anchors designed to accommodate fabrication and installation tolerances, structural loads, and thermal movement, in corrosion-resistant material and finish compatible with adjoining materials and recommended by manufacturer.

2.11 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
  - 1. Profiles that are sharp, straight, and free of defects or deformations.
  - 2. Accurately fitted joints with ends coped or mitered.
  - 3. Physical and thermal isolation of glazing from framing members.
  - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  - 5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Fabricate components to resist water penetration as follows:
  - 1. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.
    - a. Provide vertical compartmentalization at no more than every two floors in height.
    - b. Provide continuous pressure-equalized and drained sill starters at curtain wall base.
- E. Curtain-Wall Framing: Fabricate components for assembly using manufacturer's standard assembly method.
- F. Factory-Assembled Frame Units:
  - 1. Rigidly secure nonmovement joints.

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2. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions, to ensure compatibility and adhesion.
3. Preparation includes, but is not limited to, cleaning and priming surfaces.
4. Seal joints watertight unless otherwise indicated.
5. Install glazing to comply with requirements in Section 08 81 23 - Exterior Glass Glazing.

- G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.12 ALUMINUM FINISHES

- A. Superior-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer mica finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions .
  2. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
- G. Seal joints watertight unless otherwise indicated.
- H. Metal Protection:
1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
  2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

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- I. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
- J. Install components plumb and true in alignment with established lines and grades.
- K. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- L. Install weatherseal sealant according to Section 07 92 00 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

3.02 INSTALLATION OF GLAZING

- A. Install glazing as specified in Section 08 81 00 "Glass Glazing."

3.03 ERECTION TOLERANCES

- A. Design and fabricate the glazed curtain wall system to accommodate permissible dimensional tolerances in the building frame and other work adjacent to the wall. Provided irregularities do not exceed them, and clearances in Shop Drawings are maintained, all parts of the curtain wall, when completed, shall be within the following tolerances.
  - 1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
  - 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
  - 3. Alignment:
    - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
    - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
    - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
  - 4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.04 CLEANING AND PROTECTION

- A. Promptly remove from site all debris caused by or incidental to the installation work.
- B. Remove from installed Work all mastic smears or other unsightly marks caused by work of this Section. Be responsible for any damage to or disfigurement of work of other trades caused by the Work of this Section.
- C. Remove protective coverings from all exposed surfaces, and clean surfaces free of soil and discoloration.

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- D. Use cleaner acceptable to the stainless steel, aluminum, glass, sealant, gasket and aluminum finishing, and other applicable product manufacturers.
  - 1. Clean glass in accordance with GANA 01-0116, unless otherwise recommended by manufacturer.
- E. Protect curtain wall work against damage by other trades. Any repairs shall be completed in accordance with applicable product manufacturer recommendations.

3.05 FIELD QUALITY CONTROL

- A. Field-Glazed Structural Silicone Glazed Systems: Engage a site representative qualified by structural silicone sealant manufacturer to inspect substrate conditions; surface preparation; and application of structural silicone sealant.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Test Area: Perform tests on representative areas of glazed aluminum curtain walls.
- D. Water Penetration and Air Leakage Field Testing:
  - 1. Notify the Architect and Owner, in writing, a minimum of 14 days prior to conducting the field-testing.
  - 2. Testing Methodology:
    - a. Water Penetration Resistance Testing shall be conducted in accordance with ASTM E1105, Procedure A, consisting of 15 minutes induced air pressure difference.
      - 1) Field Test pressure shall be same test pressure specified in the Performance and Testing Requirements section.
      - 2) Water penetration shall be as defined in the Performance Requirements section.
    - b. Air Leakage Testing shall be conducted in accordance with ASTM E783
      - 1) Test pressure shall be 6.24 psf
      - 2) Maximum air leakage rate shall be as specified in the Performance Requirements section
  - 3. Testing Procedure and Extent:
    - a. Conduct initial field test at designated completed glazed aluminum curtain wall area selected by Architect as soon as is practical after installation of curtain wall has started. Test early during installation so that errors in fabrication or installation can be found and corrections made before remainder of glazed aluminum curtain wall assemblies are installed.
      - 1) As applicable, test area shall include interface with adjacent building envelope systems, as well as typical sill, vertical and horizontal mullions, operable vent, and stack joint. Test shall include both vision and opaque panels.
      - 2) Test Procedure:

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- a) Initial field test shall include air leakage testing followed by Water Penetration Resistance Testing.
  - b. After initial testing of earliest installation, test one area selected by Architect prior to completing 10 percent of glazed aluminum curtain wall installation, two additional tests prior to completing 30 percent of the glazed wall area and two additional tests prior to completing 50 percent of the glazed wall areas.
    - 1) As applicable, test areas shall include interface with adjacent building envelope systems, as well as typical vertical and horizontal mullions, corner mullions, stack joint, swing door, operable vent, and typical penetrations through curtain wall. Tests shall include both vision and opaque panels.
    - 2) Unless otherwise directed by Architect, each test area shall extend at least 15 feet wide by one story height.
    - 3) Test Procedure:
      - a) Testing shall consist of Water Penetration Resistance Testing only.
  - 4. If any installation fails performance tests, correct observed deficiencies and re-test at Contractor's expense. Incorporate corrective measures into all final glazed aluminum curtain wall assembly installations.
  - 5. If failure occurs at any of the performance tests, at Architects discretion, one additional area shall be tested at contractor's expense. If these installations also fail performance tests, correct observed deficiencies and re-test at Contractors expense. At Architects discretion, for each additional area that fails the testing, one additional area shall be tested. All additional testing shall be conducted at Contractors expense.
  - 6. Work that does not meet the performance requirements or that is damaged by testing shall be repaired or replaced to conform to the specified requirements.
- E. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION

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SECTION 08 56 19 - PASS WINDOWS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Sliding, transaction pass windows.

1.02 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include plans, elevations, sections, and attachments to other work.
- C. Samples: For frame members with factory-applied finishes.

PART 2 - PRODUCTS

2.01 SLIDING, TRANSACTION PASS WINDOWS

- A. Provide horizontal-sliding, transaction pass windows.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
    - a. Covenant Security Equipment; Interior Self-Closing Sliding Window Model CSE-QS-STW.
- B. Configuration: As indicated on Drawings.
- C. Framing: Fabricate framing and tracks assembly from aluminum as follows:
  - 1. Profile: Manufacturer's standard, with minimum face dimension indicated.
  - 2. Depth: Manufacturer's standard.
- D. Glazing Meeting Edges: Polished glazing.
- E. Shelf: Stainless steel, 14 inches deep by width of pass window, with integral deal tray.
- F. Sliding Window Hardware: Provide roller track designed for overhead support of horizontal-sliding glazed panel. Provide manufacturer's standard pull and lock with two keys for each horizontal-sliding glazed panel.
- G. Glazing and Glazing Materials: Manufacturer's standard materials complying with the following:
  - 1. Ballistic Resistance: Level 1 in accordance with UL 752.

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2.02 FABRICATION

- A. General: Fabricate pass windows to provide a complete system for assembly of components and anchorage of units.
  - 1. Provide units that are reglazable.
- B. Framing: Miter or cope corners the full depth of framing; weld and dress smooth.
- C. Glazing Stops: Finish glazing stops to match pass window framing.
  - 1. Secure-Side (Exterior) Glazing Stops: Welded or integral to framing.
  - 2. Nonsecure-Side (Interior) Glazing Stops: Removable, coordinated with glazing indicated.
- D. Welding: Weld components to comply with referenced AWS standard. To greatest extent possible, weld before finishing and in concealed locations to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- E. Preglazed Fabrication: Preglaze window units at factory, where required for applications indicated. Comply with requirements in Division 08 Section "Glass Glazing."

2.03 STAINLESS-STEEL FINISHES

- A. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
  - 1. Directional Satin Finish: No. 4.

2.04 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

2.05 ACCESSORIES

- A. Recessed Deal Trays: Formed from stainless steel; fabricated in curved shape with exposed flanges for recessed installation into horizontal surface.
- B. Concealed Bolts: ASTM A 307, Grade A unless otherwise indicated.
- C. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- D. Miscellaneous Glazing Materials: Provide material, size, and shape complying with requirements of glass manufacturers and with a proven record of compatibility with surfaces contacted in installation.

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- E. Anchors, Clips, and Window Accessories: Stainless steel; hot-dip, zinc-coated steel or iron, complying with ASTM B 633; provide sufficient strength to withstand design pressures indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for embedded and built-in anchors to verify actual locations of pass window connections before pass window installation.
- B. Inspect built-in and cast-in anchor installations, before installing pass windows, to verify that anchor installations comply with requirements. Prepare inspection reports.

3.02 INSTALLATION

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing pass windows to in-place construction. Include threaded fasteners for inserts, security fasteners, and other connectors.
- B. Glazed Framing: Provide sealant or gasket-glazed framing. Comply with installation requirements in Division 08 Section "Glass Glazing."
- C. Removable Glazing Stops and Trim: Fasten components with security fasteners.
- D. Fasteners: Install pass windows using fasteners recommended by manufacturer with head style appropriate for installation requirements, strength, and finish of adjacent materials. Provide stainless-steel fasteners in stainless-steel materials.

3.03 CLEANING AND PROTECTION

- A. Lubricate sliding pass window hardware.

END OF SECTION



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SECTION 08 81 00 - GLASS GLAZING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
  - 1. Storefront framing.
  - 2. Glazed curtain walls.
  - 3. Glazing sealants and accessories.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.
- C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.04 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for sealants, indicating VOC content.
- B. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Argon Gas Infill Compliance Certificate: IGCC/IGMA argon fill certification program certificates.
- D. Preconstruction adhesion and compatibility test report.

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- E. Sample Warranties: For special warranties.

1.05 QUALITY ASSURANCE

- A. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- B. Argon Gas Filled Insulating-Glass Testing Program: Fabricator shall employ non-destructive argon measuring equipment such as GasGlass by Sparklike Ltd to ensure that argon gas filled insulating glass units consistently pass IGCC/IGMA criteria for their argon fill certification programs.
- C. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- D. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
- E. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.06 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
  2. Determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates in accordance with ASTM C 1087.
  3. Submit to testing agency, number of pieces as recommended by sealant manufacturer of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
  4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
  5. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
  6. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.



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1.07 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
  - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
  - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.02 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Sealants:
    - a. VOC content limits for field applications.

2.03 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design exterior glazing.

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- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the California Building Code and ASTM E1300.
1. Design Wind Pressures: As indicated on Drawings and in accordance with ASCE 7.
  2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
  3. Differential Shading: Design tinted glass to resist thermal stresses induced by differential shading within individual glass lites.
- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites of thickness indicated.
  2. For laminated-glass lites, properties are based on products of construction indicated.
  3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
  4. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F.
  5. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
  6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.04 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. NGA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
  2. IGMA Publication Insulating Glazing Tolerances: IGMA TB-1200, "Guidelines for Insulating Glass Dimensional Tolerances."
  3. IGMA Publication for Insulating Glass: IGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
  4. IGMA Publication for Thermal Stress: IGMA TM-1500, "Guidelines to Reduce Instances of Thermal Stress."

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5. NGA Publications: "Guidelines for the Appearance of Insulating Glass Unit Edges in Commercial Applications at the Time of Installation."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
  1. Wildland-Urban Interface Fire Area Glazing: For multipane glazing, provide a minimum of one tempered safety glazing pane.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.05 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- B. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.
- C. Heat-Strengthened and Fully Tempered Float Glass: ASTM C1048, Kind HS (heat strengthened) and Kind FT (fully tempered), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
  1. Bow and Warpage Tolerance: 50 percent less than ASTM C 1048.
  2. Distortion Limits: Calculated using LiteSentry Osprey Distortion + Flatness Inspection System for Glass and Plastic.
    - a. Peak-to-Valley Roll Wave:
      - 1) Peak-to-Valley Distance:
        - a) No dimension greater than 0.005 inch, with an average not to exceed 0.003 inch, central area.
        - b) No dimension greater than 0.008 inch within 250 mm of the leading and trailing edge.
  3. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
  4. Kind HS glass greater than 1/4 inch in thickness shall meet strength requirements in accordance with ASTM C 1048.



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- D. Ceramic-Coated Vision Glass: ASTM C1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual."
- E. Silicone-Coated Spandrel Glass: ASTM C1048, Type I, Condition C, Quality-Q3.
  - 1. Opacifier: Single component, water-based factory-applied silicone coating that cures to a tack-free elastomeric film providing opacification in any color.
    - a. Basis-of-Design Product: Industrial Control Development, Inc.; OPACI-COAT-300.

2.06 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E2190.
  - 1. Sealing System: Dual seals.
  - 2. Perimeter Spacer: Provide manufacturer's standard spacer material and construction as required to meet Performance Requirements in Division 08 door, window, and framing assembly sections scheduled to receive insulating glass glazing.
    - a. Provide from one of the following:
      - 1) Aluminum with mill or clear anodic finish.
      - 2) Stainless steel.
      - 3) Polypropylene-covered stainless steel in color selected by Architect.
  - 3. Argon Gas Filled Units: Listed in the IGCC/IGMA Certified Products Directory designated "GCIA" for "Gas Content, Initial and After Weathering."
  - 4. Desiccant: Molecular sieve or silica gel, or blend of both.

2.07 GLAZING SEALANTS

- A. General:
  - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
  - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
  - 3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class as recommended by manufacturer. Use NT.



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2.08 MISCELLANEOUS GLAZING MATERIALS

- A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- B. Setting Blocks, Spacers, and Edge Blocks:
  - 1. Type recommended by sealant or glass manufacturer with a Shore A durometer hardness of 85, plus or minus 5.
- C. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

PART 3 - EXECUTION

3.01 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

3.02 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

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- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.03 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.04 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
  - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.

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3.05 GLASS GLAZING SCHEDULE

- A. GL-1: Low-E-coated, tinted insulating glass.
1. Overall Unit Thickness: 1 inch (25 mm).
  2. Minimum Thickness of Each Glass Lite: 6 mm.
  3. Outdoor Lite: Tinted heat-strengthened float glass.
    - a. Basis-of-Design Product: Vitro Architectural Glass; Optigrey.
    - b. Tint Color: Gray.
  4. Interspace Content: Air.
  5. Indoor Lite: Clear heat-strengthened float glass.
  6. Low-E Coating:
    - a. Basis-of-Design Product: Vitro Architectural Glass; Solarban 70.
    - b. Location: Sputtered on secondsurface.
- B. GL-2: Low-E-coated, tinted insulating vision glass with ceramic frit.
1. Overall Unit Thickness: 1 inch (25 mm).
  2. Minimum Thickness of Each Glass Lite: 6 mm.
  3. Outdoor Lite: Tinted, heat-strengthened float glass.
    - a. Basis-of-Design Product: Vitro Architectural Glass; Optigrey.
    - b. Tint Color: Gray.
  4. Interspace Content: Air.
  5. Indoor Lite: Clear, heat-strengthened float glass.
  6. Low-E Coating:
    - a. Basis-of-Design Product: Vitro Architectural Glass; Solarban 70.
    - b. Location: Sputtered on secondsurface.
  7. Ceramic Frit:
    - a. Pattern: 1/4-inch dots on staggered centers; 40 percent coverage.
    - b. Color: White.
    - c. Coating Location: Third surface.
- C. GL-3: Silicone-coated, low-E, insulating spandrel glass.
1. Overall Unit Thickness: 1 inch (25 mm).
  2. Minimum Thickness of Each Glass Lite: 6 mm.
  3. Outdoor Lite: Tinted heat-strengthened float glass.
    - a. Basis-of-Design Product: Vitro Architectural Glass; Optigrey.
    - b. Tint Color: Gray.
  4. Interspace Content: Air.
  5. Indoor Lite: Clear float glass.
  6. Low-E Coating:
    - a. Basis-of-Design Product: Vitro Architectural Glass; Solarban 70.
    - b. Location: Sputtered on secondsurface.
  7. Silicone Coating:
    - a. Color: As selected by Architect from manufacturer's full range
    - b. Location: Fourth surface.
- D. GL-4: Monolithic, fully tempered float glass.

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1. Glass: Clear float glass.
2. Minimum Thickness: 6 mm.

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SECTION 08 91 19 - FIXED LOUVERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Fixed metal louvers.

1.02 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
  - 1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
  - 2. Show mullion profiles and locations.
- C. Samples: For each type of metal finish required.

1.04 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.
- B. Sample Warranties: For manufacturer's special warranties.

1.05 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

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1.06 WARRANTY

- A. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain fixed louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:
  - 1. Air Balance Inc.; a Mestek company.
  - 2. Air Flow Company, Inc.
  - 3. Airolite Company, LLC (The).
  - 4. All-Lite Architectural Products.
  - 5. American Warming and Ventilating, Inc.; a Mestek company.
  - 6. Arrow United Industries; a division of Mestek, Inc.
  - 7. Construction Specialties, Inc.
  - 8. Greenheck Fan Corporation.
  - 9. Industrial Louvers, Inc.
  - 10. NCA Manufacturing, Inc.
  - 11. Reliable Products, Inc.
  - 12. Ruskin Company; Tomkins PLC.
  - 13. United Enertech Corp.

2.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
  - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
- B. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

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- C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- E. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.03 FIXED EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal Drainable-Blade Louver:
  - 1. Basis-of-Design Product: Airolite Company, LLC (The); Model K6096HP.
  - 2. Louver Depth: 6 inches.
  - 3. Frame and Blade Nominal Thickness: Not less than 0.060 inch for blades and 0.080 inch for frames.
  - 4. Mullion Type: Exposed.
  - 5. Louver Performance Ratings:
    - a. Free Area: Not less than 8.69 sq. ft. (0.79 sq. m) for 48-inch- wide by 48-inch- high louver.
    - b. Point of Beginning Water Penetration: Not less than 998 fpm.
  - 6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.04 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
  - 1. Screen Location for Fixed Louvers: Interior face.
  - 2. Screening Type: Insect screening.
- B. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 16 inches o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
  - 1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
  - 2. Finish: Same finish as louver frames to which louver screens are attached.
- D. Louver Screening for Aluminum Louvers:
  - 1. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

2.05 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.



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- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
  - 1. Use Phillips flat-head, hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
  - 2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
  - 3. For color-finished louvers, use fasteners with heads that match color of louvers.

## 2.06 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
  - 1. Frame Type: Channel unless otherwise indicated.
- C. Include supports, anchorages, and accessories required for complete assembly.
- D. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

## 2.07 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.02 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.03 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during louver installation.

3.04 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
  - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

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SECTION 09 05 61.13 - MOISTURE VAPOR EMISSION CONTROL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Fluid-applied membrane-forming systems that control the moisture-vapor-emission rate of interior concrete installed as required prior to installation of floor coverings, floor coatings, and other flooring products and systems.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
  - 2. Section 07 26 00 "Vapor Retarders" for vapor retarders under concrete slabs-on-grade.
  - 3. Division 09 Sections for flooring system substrate requirements.

1.02 DEFINITIONS

- A. MVE: Moisture vapor emission.
- B. MVER: Moisture vapor emission rate.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.04 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for coatings, indicating VOC content.
- B. Product Test Reports: For each MVE-control system, for tests performed by a qualified testing agency.
- C. Preinstallation testing reports.
- D. Field quality-control reports.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Employs factory-trained personnel who are available for consultation and Project-site inspection.

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- B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating directions for storage and mixing with other components.

1.07 FIELD CONDITIONS

- A. Environmental Limitations: Comply with MVE-control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation, and other conditions affecting system installation.
  - 1. Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than 65 deg F and not more than 85 deg F at least 48 hours before use.
  - 2. Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE-control system manufacturer, but not less than 65 deg F or more than 85 deg F and not less than 40 or more than 60 percent relative humidity, for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.
  - 3. Install MVE-control systems where concrete surface temperatures will remain a minimum of 5 deg F higher than the dew point for ambient temperature and relative humidity conditions in installation areas for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace vapor retarder and floor coverings, floor coatings, and other flooring products and systems that fail due to moisture vapor emission and moisture born contaminates within specified warranty period.
  - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Coatings:
    - a. VOC content limits for field applications.

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2.02 PERFORMANCE REQUIREMENTS

- A. MVE-Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:
  - 1. MVER: Maximum 25 lb of water/1000 sq. ft. when tested according to ASTM F1869.
  - 2. Relative Humidity: Maximum 90 percent when tested according to ASTM F2170 using in situ probes.
- B. Water-Vapor Transmission: Through MVE-control system, maximum 0.06 perm when tested according to ASTM E96/E96M.
- C. Tensile Bond Strength: For MVE-control system, greater than 200 psi with failure in the concrete according to ASTM D7234.
- D. Alkalinity Insensitivity: Insensitivity to alkaline environment up to, and including, pH 14 in a bath test when tested according to ASTM D1308.

2.03 MVE-CONTROL SYSTEM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Aquafin Building Product Systems.
  - 2. KOSTER American Corporation.
  - 3. Sika Corporation.
  - 4. Synthetics International.
- B. MVE-Control System: ASTM F3010-qualified, fluid-applied, two-component, epoxy-resin, membrane-forming system; formulated for application on concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
  - 1. Substrate Primer: Provide MVE-control system manufacturer's concrete-substrate primer if required for system indicated by substrate conditions.
  - 2. Cementitious Underlayment Primer: If required for subsequent installation of cementitious underlayment products, provide MVE-control system manufacturer's primer to ensure adhesion of products to MVE-control system.

2.04 ACCESSORIES

- A. Patching and Leveling Material: Moisture-, mildew-, and alkali-resistant product recommended in writing by MVE-control system manufacturer and with minimum of 3000-psi compressive strength after 28 days when tested according to ASTM C109/C109M.

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- B. Crack-Filling Material: Resin-based material recommended in writing by MVE-control system manufacturer for sealing concrete substrate crack repair.
- C. Cementitious Underlayment: If required to maintain manufacturer's warranty, provide MVE-control system manufacturer's cement-based underlayment.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Installation of system indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Preinstallation Testing:
  - 1. Testing Agency: Engage a qualified testing agency to perform tests.
  - 2. Alkalinity Testing: Perform pH testing according to ASTM F710. Install MVE-control system in areas where pH readings are less than 7.0 and in areas where pH readings are greater than 8.5.
  - 3. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F1869. Install MVE-control system in locations where concrete substrate MVER exceeds 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Internal Relative Humidity Test: Using in situ probes, ASTM F2170. Install MVE-control system in locations where concrete substrates exhibit relative humidity level greater than 75 percent.
  - 4. Tensile-Bond-Strength Testing: For typical locations indicated to receive installation of MVE-control system, install minimum 100-sq. ft. area of MVE-control system to prepared concrete substrate and test according to ASTM D7234.
    - a. Proceed with installation only where tensile bond strength is greater than 200 psi with failure in the concrete.
- B. Concrete Substrates: Prepare and clean substrates according to MVE-control system manufacturer's written instructions to ensure adhesion of system to concrete.

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1. Remove coatings and other substances that are incompatible with MVE-control system and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by MVE-control system manufacturer. Do not use solvents.
2. Provide concrete surface profile complying with ICRI 310.2R CSP 3 by shot blasting using apparatus that abrades the concrete surface with shot, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
3. After shot blasting, repair damaged and deteriorated concrete according to MVE-control system manufacturer's written instructions.
4. Protect substrate voids and joints to prevent resins from flowing into or leaking through them.
5. Fill surface depressions and irregularities with patching and leveling material.
6. Fill surface cracks, grooves, control joints, and other nonmoving joints with crack-filling material.
7. Allow concrete to dry, undisturbed, for period recommended in writing by MVE-control system manufacturer after surface preparation, but not less than 24 hours.
8. Before installing MVE-control systems, broom sweep and vacuum prepared concrete.

- C. Protect walls, floor openings, electrical openings, door frames, and other obstructions during installation.

3.03 INSTALLATION

- A. Install MVE-control system according to ASTM F3010 and manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fish eyes, and voids.
1. Install primers as required to comply with manufacturer's written instructions.
- B. Do not apply MVE-control system across substrate expansion, isolation, and other moving joints.
- C. Apply system, including component coats if any, in thickness recommended in writing by MVE-control system manufacturer for MVER indicated by preinstallation testing.
- D. Cure MVE-control system components according to manufacturer's written instructions. Prevent contamination or other damage during installation and curing processes.
- E. After curing, examine MVE-control system for surface deficiencies. Repair surface deficiencies according to manufacturer's written instructions.
- F. Install cementitious underlayment over cured membrane if required to maintain manufacturer's warranty and in thickness required to maintain the warranty.

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3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform installation inspections.
- B. Installation Inspections: Inspect substrate preparation and installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete MVE-control system is installed without deficiencies.
  - 1. Verify that surface preparation meets requirements.
  - 2. Verify that component coats and complete MVE-control-system film thicknesses comply with manufacturer's written instructions.
  - 3. Verify that MVE-control-system components and installation areas that evidence deficiencies are repaired according to manufacturer's written instructions.
- C. MVE-control system will be considered defective if it does not pass inspections.

3.05 PROTECTION

- A. Protect MVE-control system from damage, wear, dirt, dust, and other contaminants before floor covering installation. Use protective methods and materials, including temporary coverings, recommended in writing by MVE-control system manufacturer.
- B. Do not allow subsequent preinstallation examination and testing for floor covering installation to damage, puncture, or otherwise compromise the MVE-control system membrane.

END OF SECTION

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MOISTURE VAPOR EMISSION  
CONTROL  
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SECTION 09 21 16 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Gypsum board shaft wall assemblies.

1.02 SUBMITTALS

- A. Product Data: For each component of gypsum board shaft wall assembly.
- B. Load Tables: For shaft wall assemblies indicated to comply with performance requirements and design criteria, provide manufacturers' published load tables annotated to show compliance, for each type of framing assembly.
- C. Delegated-Design Submittal: For shaft wall assemblies indicated to comply with performance requirements and design criteria not otherwise addressed in manufacturers' published load tables, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.03 QUALITY ASSURANCE

- A. Engineering Responsibility: Preparation of design calculations, and other structural data by a qualified professional engineer.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services for assemblies that are similar to those indicated for this Project in material, design, and extent.
- C. Fire-Test-Response Characteristics: Gypsum board shaft wall assemblies shall comply with the following requirements:
1. Assembly tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
  2. Assemblies are identical to those tested per testing standard indicated by reference to designations listed by one of the following:
    - a. UL in its "Fire Resistance Directory."
    - b. Intertek ETL SEMKO in its "Directory of Listed Building Products."

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PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.
- C. Structural Performance: Provide metal framing capable of withstanding design loads within limits and under conditions indicated.
  - 1. HVAC Equipment Design Loads: Uniform air-pressure differential acting perpendicular to covering material supported by metal framing, as follows:
    - a. 5 psf.
  - 2. Elevator Velocity Design Loads: Uniform air-pressure differential acting perpendicular to covering material supported by metal framing, as follows based on elevator velocity:
    - a. 0 to 180 ft./min.: 5 psf.
    - b. 180 to 1,000 ft./min.: 7.5 psf.
    - c. 1,000 to 1,800 ft./min.: 10 psf.
- D. Deflection Limits: Design framing systems to withstand design loads without horizontal deflection greater than 1/240 of the wall height.

2.02 GYPSUM BOARD SHAFT WALL ASSEMBLIES

- A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN or Category XHDG.
- B. Where Intertek ETL SEMKO-listed systems are indicated, they refer to design numbers in Intertek ETL SEMKO's "Directory of Listed Building Products" under product category Expansion/Seismic Joints or Firestop Systems.
- C. Fire-Resistance Rating: As indicated.
- D. STC Rating: As indicated.
- E. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
  - 1. Depth: As indicated.
  - 2. Minimum Base-Metal Thickness: 0.018 inch.

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GYPSUM BOARD SHAFT WALL  
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- F. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.
  - 1. Minimum Base-Metal Thickness: As indicated.
- G. Elevator Hoistway Entrances: Manufacturer's standard J-profile jamb strut with long-leg length of 3 inches, matching studs in depth.
- H. Room-Side Finish: As indicated.
- I. Shaft-Side Finish: As indicated by fire-resistance-rated assembly design designation.
- J. Insulation: Sound attenuation blankets.

2.03 PANEL PRODUCTS

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- B. Gypsum Shaftliner Board, Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with paper faces.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. American Gypsum; Shaft Liner.
    - b. CertainTeed Corp.; ProRoc Shaftliner.
    - c. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; ToughRock Fireguard Shaftliner.
    - d. Lafarge North America, Inc.; Firecheck Type X Shaftliner.
    - e. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner.
    - f. PABCO Gypsum; Pabcore Shaftliner Type X.
    - g. Temple-Inland Inc.; Fire-Rated SilentGuard Gypsum Shaftliner System.
    - h. USG Corporation; Sheetrock Brand Gypsum Liner Panel.
  - 2. Thickness: 1 inch.
  - 3. Long Edges: Double bevel.
- C. Gypsum Shaftliner Board, Moisture- and Mold-Resistant Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with moisture- and mold-resistant core and surfaces.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. CertainTeed Corp.; ProRoc Moisture and Mold Resistant Shaftliner.
    - b. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; Dens-Glass Ultra Shaftliner.
    - c. Lafarge North America, Inc.; Firecheck Moldcheck Type X Shaftliner.
    - d. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner XP.
    - e. PABCO Gypsum; Pabcore Mold Curb Shaftliner Type X.

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- f. Temple-Inland Inc.; Fire-Rated SilentGuard TS Mold-Resistant Gypsum Shaftliner System.
      - g. USG Corporation; Sheetrock Brand Mold Tough Gypsum Liner Panel.
    - 2. Thickness: 1 inch.
    - 3. Long Edges: Double bevel.
    - 4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
  - D. Gypsum Board, Type C: ASTM C 1396/C 1396M. Manufactured to have increased fire-resistive capability.
    - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - a. American Gypsum; Firebloc Type C.
      - b. CertainTeed Corp.; ProRoc Type C.
      - c. Georgia-Pacific Gypsum LLC; Fireguard C.
      - d. Lafarge North America Inc.; Firecheck Type C.
      - e. National Gypsum Company; Gold Bond Fire-Shield C.
      - f. PABCO Gypsum; Flame Curb Type Super C.
      - g. Temple-Inland; Type TG-C.
      - h. USG Corporation; Firecode C Core.
    - 2. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
    - 3. Long Edges: Tapered.
  - E. Gypsum Board, Type X: As specified in Section 09 29 00 "Gypsum Board."
- 2.04 NON-LOAD-BEARING STEEL FRAMING
- A. Steel Framing Members: Comply with ASTM C 645 requirements for metal.
  - B. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated.
- 2.05 AUXILIARY MATERIALS
- A. Trim Accessories: Material and shapes as specified in Section 09 29 00 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written recommendations for application indicated.
  - B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
  - C. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions.
  - D. Sound Attenuation Blankets: As specified in 098100 "Acoustic Insulation".

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- E. Acoustical Sealant: As specified in 079200 "Joint Sealants".

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and ASTM C 754 other than stud-spacing requirements.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.
- C. Sprayed Fire-Resistive Materials: Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies. After application, remove only to extent necessary for installation of gypsum board shaft wall assemblies.
- D. Building Expansion Joints: Frame both sides of expansion joints with furring and other support.
- E. Install supplementary framing around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, handrails, and similar items.  
1. Elevator Hoistway: Provide jamb struts on each side of door frame.
- F. Penetrations: Install supplementary steel framing around perimeter of penetration behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.
- G. Isolate perimeter of gypsum panels from building structure, while maintaining continuity of fire-rated construction.
- H. Firestop Tracks: Install to maintain continuity of fire-resistance-rated assembly indicated.
- I. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.
- J. Sound-Rated Shaft Wall Assemblies: Seal with acoustical sealant at perimeter of each assembly and at joints and penetrations.
- K. Cant Panels: At projections into shaft exceeding 4 inches, install 1/2- or 5/8-inch- thick gypsum board cants covering tops of projections.

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- L. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.
- M. Remove and replace panels that are wet, moisture damaged, or mold damaged.

END OF SECTION

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GYPSUM BOARD SHAFT WALL  
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SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
  - 2. Suspension systems for interior ceilings and soffits.
  - 3. Grid suspension systems for gypsum board ceilings.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Load Tables: For non-structural metal framing assemblies indicated to comply with performance requirements and design criteria, provide manufacturers' published load tables annotated to show compliance, for each type of framing assembly.
- C. Delegated-Design Submittal: For non-structural metal framing assemblies indicated to comply with performance requirements and design criteria not otherwise addressed in manufacturers' published load tables, provide analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Shop Drawings:
  - 1. Include layout, spacings, sizes, thicknesses, and types of non-structural metal framing; fabrication; and fastening and anchorage details.
  - 2. Indicate framed openings, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1.03 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. CEMCO; California Expanded Metal Products Co.
  - 2. ClarkDietrich Building Systems.
  - 3. SCAFCO Steel Stud Company.
  - 4. Steel Network, Inc. (The).

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2.02 PERFORMANCE REQUIREMENTS

- A. Design framing systems in accordance with American Iron and Steel Institute Publication AISI S220, except as otherwise shown or specified.
- B. Performance: Provide non-structural metal framing assemblies capable of withstanding design loads within limits and under conditions indicated.
  - 1. Design Load: 5 lbf/sq. ft. uniform air-pressure differential acting perpendicular to covering material supported by metal framing.
  - 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
    - a. Walls Scheduled for Brittle Finishes Including Ceramic Tile: Horizontal deflection greater than  $1/360$  of the wall height, and as recommended by wall finish manufacturer.
    - b. All Other Wall Assemblies: Horizontal deflection greater than  $1/240$  of the wall height.
    - c. Ceiling Assemblies and Suspension Systems: Vertical deflection greater than  $1/240$ .
- C. Design framed openings to withstand design loads, gravity loads, and construction tolerances with a maximum deflection not to exceed that recommended by manufacturer of product or system in opening.
- D. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.
- E. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.03 FRAMING SYSTEMS

- A. Thickness: Where metal thickness is indicated, it is a minimum. Provide framing members in thicknesses as needed to comply with requirements indicated.
- B. Framing Members, General: Comply with ASTM C754 for conditions indicated.
  - 1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
  - 2. Protective Coating: ASTM A653/A653M, G40 , hot-dip galvanized unless otherwise indicated.
- C. Studs and Tracks: ASTM C645.
  - 1. Steel Studs and Tracks:



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- a. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection .
    - b. Depth: As indicated on Drawings.
  - D. Deflection System: Where indicated, provide one of the following:
    - 1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing minimum vertical movement indicated.
    - 2. Single Long-Leg Track System: ASTM C645 top track with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
    - 3. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
    - 4. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
  - E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
    - 1. Minimum Base-Steel Thickness: As indicated on Drawings .
  - F. Pre-Fabricated Backing System: Manufacturer's proprietary shape used to provide support for wall mounted items, and as follows:
    - 1. Product: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - a. Clark Dietrich Building System:
        - 1) Notched Track.
        - 2) Backer Bar.
    - 2. Backing System Type: As required to meet performance requirements indicated.
  - G. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch- wide flanges.
    - 1. Depth: As indicated on Drawings.
    - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.
  - H. Z-Shaped Clips: With slotted or nonslotted web, face flange, minimum uncoated-steel thickness of 0.034 inch, and depth indicated.
- 2.04 SUSPENSION SYSTEMS
- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.



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- B. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- C. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.
  - 1. Depth: As indicated on Drawings.
- D. Furring Channels (Furring Members):
  - 1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
  - 2. Steel Studs and Tracks: ASTM C645.
    - a. Depth: As indicated on Drawings.

## 2.05 GRID SUSPENSION SYSTEMS

- A. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Armstrong World Industries, Inc.; "Drywall Grid Systems."
    - b. Rockfon, LLC; Chicago Metallic "Drywall Grid System."
    - c. USG Corporation; "Drywall Suspension System."
  - 2. Structural Classification: Heavy-duty system.

## 2.06 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
  - 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Masonry or Concrete Walls: Provide one of the following:
  - 1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
  - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

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NON-STRUCTURAL METAL FRAMING  
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3.02 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
  - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
  - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
  - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.03 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
  - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.04 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.



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- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
1. Deflection System Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
  2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
  3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
  4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
  5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.05 INSTALLING CEILING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
    - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
    - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
  3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.



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4. Do not attach hangers to steel roof deck.
  5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
  6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
  7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION



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PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Exterior portland cement plaster (stucco).

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show locations and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other work.
- C. Samples : For each type of factory-prepared finish coat indicated.

1.03 PROJECT CONDITIONS

- A. Comply with ASTM C 926 requirements.
- B. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Zinc Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G60 zinc coating.
- B. Zinc: ASTM B 69.
- C. Extruded Aluminum: ASTM B 221, alloy type 6063 T5.
- D. Expanded-Metal Lath: ASTM C 847 with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.
  - 1. Diamond-Mesh Lath: Flat, 3.4 lb/sq. yd..
- E. Paper Backing: FS UU-B-790, Type I, Grade D, Style 2 vapor-permeable paper.
  - 1. Provide paper-backed lath unless otherwise indicated .

2.02 ACCESSORIES

- A. General: Comply with ASTM C 1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

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PORTLAND CEMENT PLASTERING  
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B. Metal Accessories:

1. Foundation Weep Screed: Fabricated from hot-dip galvanized-steel sheet, ASTM A 653/A 653M, G60 zinc coating.
2. External-Corner Reinforcement: Fabricated from metal lath with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.
3. Cornerbeads: Fabricated from extruded aluminum or zinc-coated (galvanized) steel.
  - a. Small-nose style; use unless otherwise indicated.
4. Casing Beads: Fabricated from extruded aluminum or zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
5. Control Joints: Fabricated from extruded aluminum or zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
6. Expansion Joints: Fabricated from extruded aluminum or zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
7. Two-Piece Expansion Joints: Fabricated from extruded aluminum or zinc-coated (galvanized) steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch wide; with perforated flanges.

2.03 MISCELLANEOUS MATERIALS

- A. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Bonding Compound: ASTM C 932.
- C. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of no fewer than three exposed threads.
- D. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 1063.
- E. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch diameter, unless otherwise indicated.

2.04 PLASTER MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
- B. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.
- C. Sand Aggregate: ASTM C 897.

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- D. Acrylic-Based Finish Coatings: Factory-mixed acrylic-emulsion coating systems, formulated with colorfast mineral pigments and fine aggregates; for use over portland cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Acrocrete, BASF Wall Systems, Inc.; Acrotex.
    - b. California Stucco Products Corp.; Texture Flex.
    - c. Dryvit Systems, Inc.; Dryvit TAFS.
    - d. El Rey Stucco Company, Inc., a brand of ParexLaHabra, Inc.; Prema-Flex.
    - e. Finestone, BASF Wall Systems, Inc.; PebbleTex.
    - f. LaHabra, a brand of ParexLaHabra, Inc.; Acrylic Finish.
    - g. Master Wall Inc.; Superior Finishes.
    - h. Omega Products International, Inc.; Omega Flex Finishes.
    - i. Parex, Inc., a brand of ParexLaHabra, Inc.; e-lastic.
    - j. Pleko Group LLC Products, Inc.; Pleko Structure Finishes.
    - k. Senergy, BASF Wall Systems, Inc.; Senerflex.
    - l. Shamrock Stucco LLC; Stucco Acrylic Finish.
    - m. Sto Corp.; Powerwall Finish.
    - n. Stuc-O-Flex International, Inc.; Elastomeric Finish
    - o. Surewall, a brand of ParexLaHabra, Inc.; Acrylic Finish.
    - p. SonoWall, BASF Wall Systems, Inc.; StuccoTex Finish.
  2. Color: As selected by Architect from manufacturer's full range.

2.05 PLASTER MIXES

- A. General: Comply with ASTM C 926 for applications indicated.
- B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
1. Portland Cement Mixes:
    - a. Scratch Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
    - b. Brown Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
- C. Factory-Prepared Finish-Coat Mixes: For acrylic-based finish coatings, comply with manufacturer's written instructions.



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PART 3 - EXECUTION

3.01 PREPARATION

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
- B. Prepare solid substrates for plaster that are smooth or that do not have the suction capability required to bond with plaster according to ASTM C 926.

3.02 INSTALLATION, GENERAL

- A. Acoustical Sealant: Where required, seal joints between edges of plasterwork and abutting construction with acoustical sealant.

3.03 INSTALLING METAL LATH

- A. Expanded-Metal Lath: Install according to ASTM C 1063.
  - 1. Partition Framing and Vertical Furring: Install flat diamond-mesh lath.

3.04 INSTALLING ACCESSORIES

- A. Install according to ASTM C 1063 and at locations indicated on Drawings.
- B. Reinforcement for External Corners:
  - 1. Install lath-type, external-corner reinforcement at exterior locations.
  - 2. Install cornerbead at exterior locations.
- C. Control Joints: Install control joints in specific locations approved by Architect for visual effect as follows:
  - 1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
    - a. Vertical Surfaces: 144 sq. ft..
    - b. Horizontal and other Nonvertical Surfaces: 100 sq. ft..
  - 2. At distances between control joints of not greater than 18 feet o.c.
  - 3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
  - 4. Where control joints occur in surface of construction directly behind plaster.
  - 5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

3.05 PLASTER APPLICATION

- A. General: Comply with ASTM C 926.

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- B. Walls; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork; 3/4-inch thickness.
  - 1. Portland cement mixes.
- C. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, according to manufacturer's written instructions.
- D. Concealed Exterior Plasterwork: Where plaster application will be used as a base for adhered finishes, omit finish coat.

3.06 PLASTER REPAIRS

- A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

END OF SECTION



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SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Interior gypsum board.
- B. Related Sections:
  - 1. Section 06 16 43 "Gypsum Sheathing" for gypsum sheathing for exterior applications.
  - 2. Section 07 92 00 "Joint Sealants" for acoustical sealants installed as part of STC-rated gypsum board assemblies.
  - 3. Section 09 30 00 "Tiling" for backer units installed as substrates for tile.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.04 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.



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PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. American Gypsum.
  2. CertainTeed Corp.
  3. Georgia-Pacific Gypsum LLC.
  4. Continental Building Products.
  5. National Gypsum Company.
  6. PABCO Gypsum.
  7. USG Corporation.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.03 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C1396/C1396M.
1. Thickness: 5/8 inch.
  2. Long Edges: Tapered.

2.04 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.

2.05 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
1. Interior Gypsum Board: Paper.
  2. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.

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- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
  - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
  - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping or drying-type, all-purpose compound.
    - a. Use setting-type compound for installing paper-faced metal trim accessories.
  - 3. Fill Coat: For second coat, use setting-type, sandable topping or drying-type, all-purpose compound.
  - 4. Finish Coat: For third coat, use setting-type, sandable topping or drying-type, all-purpose compound.
  - 5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.
- D. Joint Compound for Exposed Concrete Ceilings and Soffits:
  - 1. Skim Coat: Setting-type, sandable topping compound.

2.06 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
- C. Sound Attenuation Blankets: As specified in Division 09 Section "Acoustic Insulation."
- D. Acoustical Joint Sealant: As specified in Division 07 Section "Sealants."
- E. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.02 INSTALLATION AND FINISHING OF PANELS, GENERAL

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
  - 2. Fit gypsum panels around ducts, pipes, and conduits.
  - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

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- J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

### 3.03 INSTALLATION OF INTERIOR GYPSUM BOARD

- A. Single-Layer Application:
  - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
  - 2. On partitions/walls, apply gypsum panels vertically (parallel to framing) or horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
    - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
    - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
  - 3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- B. Multilayer Application:
  - 1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
  - 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
  - 3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
  - 4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.



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3.04 INSTALLATION OF TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
  - 1. Cornerbead: Use at outside corners unless otherwise indicated.
  - 2. LC-Bead: Use at exposed panel edges.
  - 3. L-Bead: Use where indicated.
  - 4. U-Bead: Use where indicated.

3.05 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
  - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
  - 2. Level 4: Surfaces scheduled for light-textured finishes, wallcoverings, flat paints and panel surfaces that will be exposed to view, unless otherwise indicated.
    - a. Primer and its application to surfaces are specified in other Division 09 Sections.
  - 3. Level 5: Surfaces scheduled for gloss and semigloss coatings, wall and ceiling areas abutting window mullions or skylights, curved surfaces, long hallways, large surface areas flooded with artificial and/or natural lighting and where indicated on Drawings.
    - a. Primer and its application to surfaces are specified in other Division 09 Sections.

3.06 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

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- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

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SECTION 09 30 00 - TILING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Ceramic tile.
  - 2. Gauged porcelain tile panels.
  - 3. Tile backing panels.
  - 4. Waterproof membrane.
  - 5. Crack isolation membrane.
  - 6. Metal edge strips.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
  - 2. Section 07 92 00 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.02 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 and ANSI A137.3 apply to Work of this Section unless otherwise specified.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Initial Selection: For tile, grout, and accessories involving color selection.
- D. Samples for Verification:
  - 1. Full-size units of each type and composition of tile and for each color and finish required.
  - 2. Full-size units of each type of trim and accessory for each color and finish required.
  - 3. Metal edge strips in 6-inch lengths.

1.04 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:

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1. Documentation for sealers, indicating VOC content.

1.05 QUALITY ASSURANCE

- A. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

1.06 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers for Setting and Grouting Materials:
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ARDEX Americas.
    - b. Custom Building Products.
    - c. H.B. Fuller Construction Products Inc. / TEC.
    - d. Laticrete International, Inc.
    - e. MAPEI Corporation.
    - f. Parex USA, Inc.
- B. Source Limitations for Setting and Grouting Materials: Obtain setting and grouting materials from single manufacturer and aggregate from single source or producer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
  1. Waterproof membrane.
  2. Crack isolation membrane.
  3. Backer units.
  4. Metal edge strips.

2.02 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  1. Sealers:
    - a. VOC content limits for field applications.

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2.03 PERFORMANCE REQUIREMENTS

- A. Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products in accordance with:
  - 1. Level Surfaces Not Subject To Wetting: SCOF of not less than 0.50 in accordance with ANSI A1264.2, Section E11.2.
  - 2. Level Surfaces Subject To Wetting: DCOF of not less than 0.42 in accordance with ANSI A137.1.

2.04 CERAMIC TILE PRODUCTS

- A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
- B. Ceramic Tile: Vitreous or impervious natural clay or porcelain; 1/4 inch thick, unless otherwise indicated. As scheduled on Drawings and as follows:
  - 1. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as indicated on Drawings, selected from manufacturer's standard shapes:

2.05 GAUGED PORCELAIN TILE PANEL PRODUCTS

- A. ANSI Gauged Porcelain Tile Panels Standard: Provide Standard Grade gauged porcelain tile panels that comply with ANSI A137.3 for types and other characteristics indicated.
- B. Gauged Porcelain Tile Panel: Impervious porcelain tile panel manufactured to specified nominal thickness and greater than or equal to 1 sq. m.; 6 mm nominal thickness, unless otherwise indicated. As scheduled on drawings:

2.06 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. CertainTeed Corporation; GlasRoc Tile Backer.
    - b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
    - c. National Gypsum Company; eXP Tile Backer.
    - d. USG Corporation; Durock Glass-Mat Tile Backerboard.
  - 2. Core: 5/8 inch, Type X.
  - 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.



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2.07 WATERPROOF MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030 inch nominal thickness.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Noble Company (The); Nobleseal TS.
- C. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, SBS-modified-bituminous sheet with fabric reinforcement facing; 0.040-inch nominal thickness.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. National Applied Construction Products, Inc.; Strataflex.
    - b. Protecto Wrap; AFM-WM.
- D. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Boiardi Products Corporation; a QEP company; Elastiment 344 Reinforced Waterproofing and Anti-Fracture/Crack Suppression Membrane.
    - b. Bonsal American, an Oldcastle company; B 6000 Waterproof-Crack Isolation Membrane with B 6000 Mesh.
    - c. Bostik, Inc; Hydroment Blacktop 90210.
    - d. Custom Building Products; Custom 9240 Waterproofing and Anti-Fracture Membrane.
    - e. Laticrete International, Inc.; Laticrete 9235 Waterproof Membrane.
    - f. Parex USA, Inc.; Hydro-Guard 2000.
    - g. Schönox; HPS North America, Inc.; Schönox HA.
    - h. Summitville Tiles, Inc.; S-9000.

2.08 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch nominal thickness.

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1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Noble Company (The); Nobleseal CIS.
- C. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Bostik, Inc; Hydroment GoldPlus.
    - b. Custom Building Products; RedGard Waterproofing and Crack Prevention Membrane.
    - c. H.B. Fuller Construction Products Inc. / TEC; HydraFlex - Waterproofing Crack Isolation Membrane.
    - d. Laticrete International, Inc.; Laticrete Hydro Ban.
    - e. MAPEI Corporation; Mapelastic CI.

2.09 SETTING MATERIALS

- A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
  1. Cleavage Membrane: Asphalt felt, ASTM D226/D226M, Type I (No. 15); or polyethylene sheeting, ASTM D4397, 4.0 mils thick.
  2. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A185/A185M and ASTM A82/A82M, except for minimum wire size.
  3. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
- B. Modified Dry-Set Mortar (Thinset): ANSI A118.4.
  1. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
- C. Improved Modified Dry-Set Mortar (Thinset): ANSI A118.15.
  1. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
- D. Modified Dry-Set Mortar for Large and Heavy Tile (Medium-Bed): Comply with requirements in ANSI A118.4. Provide product that is approved by manufacturer for application thickness of 5/8 inch.
  1. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
- E. Improved Modified Dry-Set Mortar for Large and Heavy Tile (Medium-Bed): Comply with requirements in ANSI A118.15. Provide product that is approved by manufacturer for application thickness of 5/8 inch.
  1. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

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2.10 GROUT MATERIALS

- A. Grout Colors: As indicated on Drawings.
- B. High-Performance Tile Grout: ANSI A118.7.

2.11 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Metal Edge Strips: Profile as indicated, height to match tile and setting-bed thickness, designed specifically for tiling applications.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Blanke Corporation.
    - b. Ceramic Tool Company, Inc.
    - c. Schluter Systems L.P.
  - 2. Exposed Finish: As indicated by manufacturer's designations.
- C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- D. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Custom Building Products; Grout and Tile Sealer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 and ANSI A108.19 for installations indicated.

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2. Verify that concrete substrates for tile floors installed with bonded mortar bed or dry-set mortar comply with surface finish requirements in ANSI A108.01 and ANSI A108.19 for installations indicated.
    - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
  3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
  4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with dry-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.03 INSTALLATION OF TILE BACKING PANEL

- A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use modified dry-set mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.04 INSTALLATION OF WATERPROOF MEMBRANE

- A. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
- B. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

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3.05      INSTALLATION OF CRACK ISOLATION MEMBRANE

- A.      Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
- B.      Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.06      TILE INSTALLATION

- A.      Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used. Comply with ANSI A108.19 for installation of gauged porcelain tile panels.
  - 1.      For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
    - a.      Tile floors in wet areas.
    - b.      Tile floors consisting of tiles 8 by 8 inches or larger.
  - 2.      For the following installations, provide 80 percent mortar coverage:
    - a.      Gauged porcelain tile panels for walls.
- B.      Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C.      Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D.      Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
- E.      Joint Widths: Unless otherwise indicated, install tile with joint widths as recommended by tile manufacturer.
- F.      Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
  - 1.      Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

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2. Locate expansion joints as recommended by tile and tile installation material manufacturers, but not less than the following:
  - a. Interior Locations: 20-25 feet in each direction.
  - b. Interior Locations at Above Ground Concrete Slabs: 8-12 feet in each direction.
  - c. Interior Locations Exposed to Direct Sunlight or Moisture: 8-12 feet in each direction.
  - d. Exterior Locations: 8-12 feet in each direction.
  - e. Perimeter joints.

G. Metal Edge Strips: Install at locations indicated .

H. Grout Sealer: Apply grout sealer to grout joints according to sealer manufacturer's written instructions. As soon as sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

### 3.07 CLEANING AND PROTECTION

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all tile surfaces so they are free of foreign matter.
  1. Remove grout residue from tile as soon as possible.
  2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
- C. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- D. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- E. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

### 3.08 INTERIOR TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations:
  1. Ceramic Tile Over Concrete:

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- a. TCNA F112: On-ground and above-ground concrete; Cured mortar bed; ANSI A108.1B.
  - 1) Membrane: Waterproof membrane.
  - 2) Mortar: Modified dry-set or Improved modified dry-set mortar as recommended by manufacturer.
    - a) Provide thinset mortar unless medium-bed mortar is recommended by tile or mortar manufacturer.
  - 3) Grout: High-performance grout, sanded or unsanded as recommended by tile manufacturer .
- b. TCNA F113, F113A: On-ground and above-ground concrete.
  - 1) Membrane: Crack-isolation membrane, in accordance with installation method TCNA F125-Full.
  - 2) Mortar: Modified dry-set or Improved modified dry-set mortar as recommended by manufacturer.
    - a) Provide thinset mortar unless medium-bed mortar is recommended by tile or mortar manufacturer.
  - 3) Grout: High-performance grout, sanded or unsanded as recommended by tile manufacturer .
- c. TCNA F122, 122A: On-ground and above-ground concrete; Waterproof membrane.
  - 1) Membrane: Waterproof membrane.
  - 2) Mortar: Modified dry-set or Improved modified dry-set mortar as recommended by manufacturer.
    - a) Provide thinset mortar unless medium-bed mortar is recommended by tile or mortar manufacturer.
  - 3) Grout: High-performance grout, sanded or unsanded as recommended by tile manufacturer .
- d. TCNA F125-Full: On-ground and above-ground concrete; Crack isolation membrane.
  - 1) Use with tile types that are 6 by 6 inches or larger, in conjunction with corresponding installation method.
- e. TCNA F205, 205A: On-ground and above-ground concrete; Cementitious self-leveling underlayment.
  - 1) Use in locations requiring self-leveling underlayment, in conjunction with corresponding installation method.

B. Interior Wall Installations:

- 1. Ceramic Tile Over Wood or Metal Studs:
  - a. TCNA W245: Wood or metal studs; Coated glass-mat, water-resistant gypsum backer board.
    - 1) Membrane: Waterproof membrane.
    - 2) Mortar: Modified dry-set or Improved modified dry-set mortar as recommended by manufacturer.
      - a) Provide thinset mortar unless medium-bed mortar is recommended by tile or mortar manufacturer.



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- 3) Grout: High-performance grout, sanded or unsanded as recommended by tile manufacturer .

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SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Acoustical panels and exposed suspension systems for interior ceilings.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for ceiling products, indicating compliance with emissions testing or certification.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.06 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

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PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide products indicated or comparable product by one of the following:
  - 1. Armstrong World Industries, Inc.
  - 2. CertainTeed Corporation.
  - 3. Rockfon (Rockwool International).
  - 4. USG Corporation.
- B. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.02 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Ceiling Products:
    - a. VOC emissions testing or certification.

2.03 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: Class A according to ASTM E1264.
  - 2. Smoke-Developed Index: 50 or less.

2.04 ACOUSTICAL PANELS

- A. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264.
- B. Basis-of-Design Product: As indicated on Drawings.

2.05 METAL SUSPENSION SYSTEM

- A. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M and designated by type, structural classification, and finish indicated.
  - 1. Structural Classification: Heavy-duty system, unless noted otherwise.
- B. Metal Suspension System:

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1. Basis-of-Design Product: As indicated on Drawings.

## 2.06 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
  1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
  2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch- diameter wire.
- C. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
- D. Seismic Perimeter Retention System:
  1. Seismic Perimeter Clips: Manufacturer's standard clips designed to accommodate seismic forces.
    - a. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
      - 1) Armstrong World Industries, Inc; BERC Series.
      - 2) USG Corporation; ACM7 Seismic Clip.
    - b. Molding Profile: Manufacturer's standard 7/8-inch-wide profile, as selected by Architect.

## 2.07 METAL EDGE MOLDINGS AND TRIM

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
  1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
  2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
  3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

## 2.08 ACOUSTICAL SEALANT

- A. Acoustical Sealant: As specified in Section 07 92 00 "Joint Sealants."



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PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

3.03 INSTALLATION

- A. Install acoustical panel ceilings according to ASTM C636/C636M, seismic design requirements, and manufacturer's written instructions.
- B. Suspend ceiling hangers from building's structural members and as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.



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5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
  6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
  7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  8. Do not attach hangers to steel deck tabs.
  9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
  11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
  2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
  3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
1. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
  2. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.



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3.04 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION



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SECTION 09 54 23 - LINEAR METAL CEILINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Linear metal ceilings.

1.02 COORDINATION

- A. Coordinate layout and installation of linear metal pans and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.03 ACTION SUBMITTALS

- A. Product Data: For linear metal ceilings.
- B. Shop Drawings: For linear metal ceilings.
  - 1. Include reflected ceiling plans, sections, and details, drawn to scale, showing the following:
    - a. Linear ceiling patterns and joints.
    - b. Ceiling suspension members.
    - c. Method of attaching hangers to building structure and locations of cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
    - d. Ceiling-mounted items including, but not limited to, light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
    - e. Ceiling perimeter and penetrations through ceiling; trim and moldings.
- C. Samples: For each exposed product and for each type, color, and finish specified, 12 inches long in size.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ceiling components and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Handle ceiling components and accessories in a manner that prevents damage.

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1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install interior ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Exterior linear metal ceilings to withstand exterior exposure, the effects of gravity loads, and the following loads and stresses without showing permanent deformation of ceiling system components, including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling pans; or permanent damage to fasteners and anchors:
1. Wind Loads: As indicated on Drawings.
  2. Other Design Loads: As indicated on Drawings.
  3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F material surfaces.
- C. Seismic Criteria: Provide linear metal ceilings designed and installed to withstand the effects of earthquake motions in accordance with ASCE/SEI 7 and requirements of authorities having jurisdiction.

2.02 LINEAR METAL CEILINGS

- A. Pans and Suspension System:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. American Decorative Ceilings, Inc.
    - b. Armstrong Ceiling & Wall Solutions.
    - c. CertainTeed Corporation.
    - d. Rockfon; ROCKWOOL International.
    - e. USG Corporation.
- B. Metal Pans: Complying with ASTM E1264 for Type XIII or Type XX and formed to snap on to carriers securely, without separate fasteners.
1. Surface-Burning Characteristics: For metal-pan assemblies, including backings, determined by testing in accordance with ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    - a. Flame-Spread Index: 25 or less.

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- b. Smoke-Developed Index: 50 or less.
- 2. Pan Edge Detail: Manufacturer's standard.
- 3. Metal-Pan Finish: Protected on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping and as follows:
  - a. Color-Coated Finish: Manufacturer's standard baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.
    - 1) Color and Pattern: As indicated by manufacturer's product designation.
- C. Moldings and Trim: Manufacturer's standard for exposed members, to conceal edges of penetrations through ceiling, to conceal ends of pans and carriers, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching linear metal pans or extruded plastic unless otherwise indicated.
  - 1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.
- D. Carrier Suspension System: Manufacturer's standard complying with requirements in ASTM C635/C635M for applications indicated; complete with carriers, splice sections, stabilizing components, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, fixture adapters, and other suspension components required to support ceiling units and other ceiling-supported construction.
  - 1. Structural Classification: Heavy-duty system.
  - 2. Stabilizer Channels, Tees, and Bars: Manufacturer's standard components for stabilizing main carriers.
  - 3. Carrier Splices: Same metal, profile, and finish as for carriers.
  - 4. Hold-Down Clips: Manufacturer's standard hold-down clips spaced as standard with manufacturer.
  - 5. Carrier Finish: Flat black.

2.03 CARRIER-SYSTEM HANGERS, BRACES, AND TIES

- A. Attachment Devices: Size for 5 times the design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated.
- B. Wire Hangers, Braces, and Ties: Provide wire complying with the following requirements:
  - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
  - 2. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C635/C635M, Table 1, Direct Hung is less than yield stress of wire, but provides not less than 0.106-inch- diameter wire.
- C. Seismic Struts: Suspension-system manufacturer's standard compression struts designed to accommodate seismic forces.



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- D. Exterior Bracing: Cold-rolled steel channels and angles, hot-dip galvanized to comply with ASTM A653/A653M, G60 coating designation; size and profile as required to withstand wind load.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which linear metal ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of linear metal ceilings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Measure each ceiling area and establish layout of linear metal pans.
  - 1. Balance border widths at opposite edges of each ceiling.
  - 2. Avoid using less-than-half-width pans at borders.

### 3.03 INSTALLATION OF LINEAR METAL CEILINGS

- A. Comply with ASTM C636/C636M and seismic requirement indicated, in accordance with manufacturer's written instructions.
- B. Suspend ceiling hangers from building's structural members and as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  - 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns in 3 inches. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate to which hangers are attached and for type of hanger involved.



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5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
  6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts or postinstalled mechanical or adhesive anchors that extend through forms into concrete.
  7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  8. Do not attach hangers to steel deck tabs.
  9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
  11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns in 1-1/2 inches. Suspend bracing from building's structural members as required for hangers and without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim at perimeter of linear metal ceiling area and where necessary to conceal edges and ends of linear metal pans.
1. Screw attach moldings to substrate at intervals of not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
  2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system carriers so they are aligned and securely interlocked with one another.
1. Install stabilizer channels, tees, and bars at regular intervals to stabilize carriers and at light fixtures, air-distribution equipment, access doors, and other equipment; spaced as standard with manufacturer for use indicated.
  2. Remove and replace dented, bent, or kinked members.
- F. Cut linear metal pans for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness.
- G. Install linear metal pans in coordination with suspension system and exposed moldings and trim.
1. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated on Drawings.

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LINEAR METAL CEILINGS  
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2. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating ceiling.
3. Install directionally textured or patterned metal pans in directions indicated.
4. Where metal pan ends are visible, install end caps unless trim is indicated.

3.04 CLEANING

- A. Clean exposed surfaces of linear metal ceilings, including trim and edge moldings, after removing strippable, temporary protective covering if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION



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SECTION 09 65 00 - RESILIENT FLOORING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Resilient tile flooring.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
  - 2. Section 09 65 13 "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with resilient floor coverings.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of resilient flooring.
  - 1. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
- C. Samples: For each exposed product and for each color, texture, and pattern specified, in manufacturer's standard size, but not less than 6-by-9-inch sections.
- D. Product Schedule: For resilient flooring. Use same designations indicated on Drawings.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for adhesives , indicating VOC content.
  - 2. Documentation for flooring products, indicating compliance with emissions testing or certification.
- B. Qualification Data: For Installer.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of resilient flooring to include in maintenance manuals.

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1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for resilient flooring installation and seaming method indicated.
  - 1. Engage an installer who employs workers for this Project who are trained or certified by resilient flooring manufacturer for installation techniques required.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store rolls upright.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F, in spaces to receive resilient flooring during the following periods:
  - 1. 48 hours before installation.
  - 2. During installation.
  - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during resilient flooring installation.
- D. Close spaces to traffic for 48 hours after resilient flooring installation.
- E. Install resilient flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Adhesives:
    - a. VOC content limits for field applications.
  - 2. Flooring Products:
    - a. VOC emissions testing or certification.

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2.02 RESILIENT TILE FLOORING

- A. Solid Vinyl Floor Tile:
  - 1. Tile Standard: ASTM F1700.
    - a. Class and Type: As indicated by product designations.
  - 2. Colors and Patterns: As indicated by manufacturer's designations.

2.03 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient flooring manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient flooring and substrate conditions indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
  - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient flooring.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare substrates according to resilient flooring manufacturer's written instructions to ensure adhesion of resilient flooring.
- B. Concrete Substrates: Prepare according to ASTM F710.
  - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient flooring manufacturer. Do not use solvents.
  - 3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.



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4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
  - C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
  - D. Do not install resilient flooring until materials are the same temperature as space where they are to be installed.
    1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.
  - E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient flooring.
- 3.03 FLOOR TILE INSTALLATION
- A. Comply with manufacturer's written instructions for installing floor tile.
  - B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
  - C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
  - D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
  - E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
  - F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
  - G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

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- H. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.04 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient flooring.
- B. Perform the following operations immediately after completing resilient flooring installation:
  - 1. Remove adhesive and other blemishes from surfaces.
  - 2. Sweep and vacuum surfaces thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect resilient flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient flooring until Substantial Completion.

END OF SECTION



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SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Resilient base.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for adhesives, indicating VOC content.
  - 2. Documentation for resilient base, indicating compliance with emissions testing or certification.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.05 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:
  - 1. 48 hours before installation.
  - 2. During installation.
  - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.



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- C. Install resilient products after other finishing operations, including painting, have been completed.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide products indicated on Drawings, or comparable products by one of the following:
  - 1. Allstate Rubber Corp.
  - 2. Flexco.
  - 3. Johnsonite.
  - 4. Mannington Commercial.
  - 5. Roppe.
  - 6. VPI, LLC, Floor Products Division.

### 2.02 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Adhesives:
    - a. VOC content limits for field applications.
  - 2. Resilient Base:
    - a. VOC emissions testing or certification.

### 2.03 RESILIENT BASE

- A. Product Standard: One of the following:
  - 1. ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
  - 2. ASTM F1861, Type TP (rubber, thermoplastic).
- B. Style and Location:
  - 1. Style A, Straight: Provide in areas with carpet.
  - 2. Style B, Cove: Provide in areas with resilient floor coverings.
- C. Thickness: 0.125 inch.
- D. Height: As indicated on Drawings.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed or preformed.
- G. Inside Corners: Job formed or preformed.

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- H. Colors: As indicated by manufacturer's designations .

2.04 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.03 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.



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- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
  - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
    - a. Form without producing discoloration (whitening) at bends.
  - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
    - a. Miter or cope corners to minimize open joints.

3.04 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
  - 1. Remove adhesive and other blemishes from surfaces.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION



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SECTION 09 65 43 - LINOLEUM FLOORING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Linoleum floor tile.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of linoleum flooring.
  - 1. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
  - 2. Show details of special patterns.
- C. Samples: For each exposed product and for each color and pattern specified in manufacturer's standard size, but not less than 6-by-9-inch sections.
  - 1. Heat-Welding Bead: Include manufacturer's standard-size Samples, but not less than 9 inches long, of each color required.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for adhesives, indicating VOC content.
  - 2. Documentation for flooring products, indicating compliance with emissions testing or certification.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of linoleum flooring to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for flooring installation and seaming methods indicated.
  - 1. Engage an installer who employs workers for this Project who are trained or certified by flooring manufacturer for installation techniques required.

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1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 65 deg F or more than 90 deg F.
  - 1. Floor Tile: Store on flat surfaces.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive flooring during the following periods:
  - 1. 72 hours before installation.
  - 2. During installation.
  - 3. 72 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during flooring installation.
- D. Close spaces to traffic for 72 hours after flooring installation.
- E. Install flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Adhesives:
    - a. VOC content limits for field applications.
  - 2. Flooring Products:
    - a. VOC emissions testing or certification.

2.02 LINOLEUM FLOOR TILE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings, or comparable product by approved manufacturer.
- B. Linoleum Floor Tile: ASTM F2195, Type as indicated by manufacturer's designations.
  - 1. Nominal Floor Tile Size: Manufacturer's standard.

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- C. Thickness: 0.10 inch.
- D. Colors and Patterns: As indicated by manufacturer's designations.

2.03 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by linoleum flooring manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit products and substrate conditions indicated.
- C. Floor Polish: Provide protective, liquid floor-polish products recommended by linoleum flooring manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
  - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of flooring.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare substrates according to linoleum flooring manufacturer's written instructions to ensure adhesion of flooring.
- B. Concrete Substrates: Prepare according to ASTM F710.
  - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  - 2. Remove substrate coatings and other substances that are incompatible with flooring adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by linoleum flooring manufacturer. Do not use solvents.
  - 3. Alkalinity and Adhesion Testing: Perform tests recommended by linoleum flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.



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4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
  - C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
  - D. Do not install flooring until materials are the same temperature as space where they are to be installed.
    1. At least 72 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.
  - E. Immediately before installation, sweep and vacuum clean substrates to be covered by flooring.
- 3.03 INSTALLATION, GENERAL
- A. Comply with manufacturer's written instructions for installing flooring.
  - B. Scribe and cut flooring to butt neatly and tightly to vertical surfaces and permanent fixtures, including built-in furniture, cabinets, pipes, outlets, edgings, thresholds, door frames, and nosings.
  - C. Extend flooring into toe spaces, door reveals, closets, and similar openings.
  - D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on flooring as marked on substrates. Use chalk or other nonpermanent marking device.
  - E. Install flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.
  - F. Adhere flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.



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- G. Heat-Welded Seams: For seamless installation, comply with ASTM F1516. Rout joints and heat weld with welding bead to fuse sections permanently into a seamless flooring installation. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.

3.04 LINOLEUM FLOOR TILE INSTALLATION

- A. Lay out linoleum floor tiles from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
- B. Match linoleum floor tiles for color and pattern by selecting tiles from cartons in same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.

3.05 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting linoleum flooring.
- B. Perform the following operations immediately after completing linoleum flooring installation:
  - 1. Remove adhesive and other blemishes from surfaces.
  - 2. Sweep and vacuum surfaces thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect linoleum flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from linoleum flooring surfaces before applying liquid floor polish.
- E. After allowing drying room film (yellow film caused by linseed oil oxidation) to disappear, cover linoleum flooring until Substantial Completion.

END OF SECTION



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SECTION 09 68 13 - TILE CARPETING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Modular carpet tile.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
  - 2. Section 09 65 13 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
  - 2. Include manufacturer's written installation recommendations for each type of substrate.
- B. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
  - 1. Carpet Tile: Full-size Sample.
  - 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.
- C. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for adhesives, indicating VOC content.
  - 2. Documentation for flooring products, indicating compliance with emissions testing or certification.
- B. Qualification Data: For Installer.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:

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1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the Carpet and Rug Institute's CRI 104.

1.07 FIELD CONDITIONS

- A. Comply with the Carpet and Rug Institute's CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  1. Adhesives:
    - a. VOC content limits for field applications.
  2. Flooring Products:
    - a. VOC emissions testing or certification.

2.02 CARPET TILE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings, or comparable product by approved manufacturer.

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- B. Size: As indicated on Drawings.
- C. Performance Characteristics:
  - 1. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm according to NFPA 253.
  - 2. Optical Smoke Density Rating: Does not exceed 450 according to ASTM E662.

2.03 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 03 30 00 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
  - 1. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
    - c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.02 PREPARATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.03 INSTALLATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- G. Install pattern parallel to walls and borders.

3.04 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:

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1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
  2. Remove yarns that protrude from carpet tile surface.
  3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with the Carpet and Rug Institute's CRI 104, Section 13.7.
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION



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SECTION 09 72 00 - WALL COVERINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Vinyl wall covering.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Sustainable Design Submittals:
  - 1. Documentation for adhesives, indicating VOC content.
- C. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement, seams and termination points.
- D. Samples: Full width by 36-inch- long section of wall covering from same print run or dye lot to be used for the Work, with specified applied. Show complete pattern repeat. Mark top and face of fabric.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for wall covering.
- F. Maintenance Data: For wall coverings to include in maintenance manuals.

1.03 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    - a. Flame-Spread Index: 25 or less.
    - b. Smoke-Developed Index: 450 or less.
  - 2. Fire-Growth Contribution: No flashover and heat and smoke release according to NFPA 286.

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1.04 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  - 1. Wood-Veneer Wall Coverings: Condition spaces for not less than 48 hours before installation.
- B. Lighting: Do not install wall covering until a permanent level of lighting is provided on the surfaces to receive wall covering.
- C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Adhesives:
    - a. VOC content limits for field applications.
- B.

2.02 WALL COVERINGS

- A. General: Provide rolls of each type of wall covering from same print run or dye lot.

2.03 VINYL WALL COVERING

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by approved manufacturer.
- B. Colors, Textures, and Patterns: As indicated on Drawings.

2.04 ACCESSORIES

- A. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific wall covering and substrate application; as recommended in writing by wall-covering manufacturer.
- B. Primer/Sealer: Mildew resistant, complying with requirements in Division 09 Section "Painting" and recommended in writing by wall-covering manufacturer for intended substrate.

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- C. Seam Tape: As recommended in writing by wall-covering manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for levelness, wall plumbness, maximum moisture content, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.
- C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
1. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
  2. Painted Surfaces: Treat areas susceptible to pigment bleeding.
- D. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.
- E. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.
- F. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.
- G. Install wall liner, with no gaps or overlaps, where required by wall-covering manufacturer. Form smooth wrinkle-free surface for finished installation. Do not begin wall-covering installation until wall liner has dried.

3.03 INSTALLATION

- A. General: Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated except where more stringent requirements apply.
- B. Cut wall-covering strips in roll number sequence. Change roll numbers at partition breaks and corners.

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- C. Install wall covering with no gaps or overlaps, no lifted or curling edges, and no visible shrinkage.
- D. Match pattern 72 inches above the finish floor.
- E. Install seams vertical and plumb at least 6 inches from outside corners and 6 inches from inside corners unless a change of pattern or color exists at corner. No horizontal seams are permitted.
- F. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.
- G. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without any overlay or spacing between strips.
- H. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.
- I. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION



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SECTION 09 77 23 - FABRIC-WRAPPED PANELS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes shop-fabricated, fabric-wrapped wall panels.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Sustainable Design Submittals:
  - 1. Documentation for acoustical wall panels, indicating compliance with emissions testing or certification.
- C. Shop Drawings: For fabric-wrapped wall panels. Include mounting devices and details.
- D. Samples: For each exposed product and for each color and texture specified.
- E. Product certificates.
- F. Maintenance data.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Acoustical Wall Panels:
    - a. VOC emissions testing or certification.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Provide fabric-wrapped wall panels meeting the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
  - 1. Surface-Burning Characteristics: As determined by testing per ASTM E 84.
    - a. Flame-Spread Index: 25 or less.
    - b. Smoke-Developed Index: 450 or less.

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2. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265.

2.03 FABRIC-WRAPPED WALL PANELS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by approved manufacturer.
- B. Fabric-Wrapped Wall Panel: Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back edge border of core.
  1. Basis-of-Design Product: Indicated on Drawings.
  2. Mounting: Back mounted with manufacturer's standard metal clips or bar hangers, secured to substrate.
  3. Core: As indicated on Drawings.
  4. Edge Construction: Manufacturer's standard chemically hardened core with no frame.
  5. Facing Material: As indicated on Drawings.
  6. Nominal Overall Panel Thickness: As indicated on Drawings.

2.04 MATERIALS

- A. Core Materials:
  1. Glass-Fiber Board: ASTM C 612; Type standard with manufacturer with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
  2. Mineral-Fiber Board: Tackable; Maximum flame-spread and smoke-developed indexes of 25 and 10, respectively.
- B. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations.
  1. Lining Material: Manufacturer's standard fabric for each use indicated.

2.05 FABRICATION

- A. General: Use manufacturer's standard construction except as otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.
- B. Facing Material: Apply fabric fully covering visible surfaces of panel; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.
  1. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent panels.
- C. Dimensional Tolerances of Finished Panels: Plus or minus 1/16 inch.

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PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install fabric-wrapped wall panels in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
- B. Comply with fabric-wrapped, wall panel manufacturer's written instructions for installation of panels using type of mounting devices indicated. Mount panels securely to supporting substrate.
- C. Align and level fabric pattern and grain among adjacent panels.
- D. Clip loose threads; remove pills and extraneous materials.
- E. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION



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SECTION 09 77 49 - COMPACT LAMINATE WALL PANELING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Interior, anchored compact laminate wall paneling.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for paneling system, including dimensions and profiles of paneling.
  - 1. Show locations and details of joints both within paneling system and between paneling system and other finish materials.
  - 2. Show locations and details of anchors, including locations of supporting construction.
  - 3. Show direction of pattern, grain, or other directional pattern.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Maintenance data.

1.03 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Provide compact laminate wall panels meeting the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
  - 1. Surface-Burning Characteristics: As determined by testing per ASTM E 84.
    - a. Flame-Spread Index: 25 or less.
    - b. Smoke-Developed Index: 450 or less.

1.04 FIELD CONDITIONS

- A. Maintain air and material temperatures to comply with requirements of installation material manufacturers, but not less than 50 deg F during installation and for seven days after completion.
- B. Field Measurements: Verify dimensions of construction to receive paneling by field measurements before fabrication and indicate measurements on Shop Drawings.

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PART 2 - PRODUCTS

2.01 COMPACT LAMINATE WALL PANELS

- A. Basis-of-Design Product Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by approved manufacturer.
- B. Compact Laminate Wall Panel: Manufacturer's standard panel construction consisting of facing material laminated to phenolic core with the following properties:
  - 1. Panel Size: As indicated on drawings.
  - 2. Panel Thickness: As indicated on Drawings..
  - 3. Color and Texture: As indicated on Drawings.

2.02 ACCESSORIES

- A. Mounting System: Fabricate mounting system anchored on back of panels, and as recommended by mounting system manufacturer to support weight of panels, and as follows:
  - 1. Basis-of-Design System: As indicated on Drawings.
  - 2. Trim: 1-4 inch post termination.
  - 3. Finish: Clear anodized aluminum.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install wall panels in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
  - 1. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/8 inch in 96 inches, 1/4 inch maximum.
  - 2. Variation from Level: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, 3/8 inch maximum.
  - 3. Variation in Joint Width: Do not vary from average joint width more than plus or minus 1/16 inch or one-fourth of nominal joint width, whichever is less.
  - 4. Variation in Plane between Adjacent Panel Units (Lipping): Do not exceed 1/32-inch difference between planes of adjacent units.
- B. Anchor paneling to supporting substrate with mounting system. Do not use face fastening.
- C. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

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3.02 ADJUSTING AND CLEANING

- A. Repair damaged and defective paneling, where possible, to eliminate defects; where not possible to repair, replace paneling. Adjust for uniform appearance.

END OF SECTION

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SECTION 09 78 13 - METAL INTERIOR WALL PANELING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Metal panels and associated attachment system for interior walls.

1.02 SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:
  - 1. Metal Panels: Set of 6-inch- square Samples of each type, finish, color, pattern, and texture. Show pan edge profile.
- C. Maintenance Data: For finishes to include in maintenance manuals.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Deliver metal panels, attachment system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
  - 2. Smoke-Developed Index: 450 or less.

2.02 METAL PANELS, GENERAL

- A. Source Limitations: Obtain each type of metal panel and attachment system from single source from single manufacturer.
- B. Sheet Metal Characteristics: For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.



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2.03 INTERIOR METAL WALL PANELS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or a comparable product by approved manufacturer.
- B. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.
  - 1. Hook-in Pans: Designed to hook in and be securely retained in slotted metal hat channel provided by manufacturer.
  - 2. Material: Galvanized steel sheet.
- C. Pan Edge Detail: Manufacturer's standard edge detail.
- D. Pan Joint Detail: Butt.
- E. Pan Size: As indicated on Drawings.
- F. Pan Face Finish: As indicated on Drawings.
- G. NRC: Not less than 0.70.

2.04 METAL ATTACHMENT SYSTEM

- A. Attachment System: Provide system complete with channels, splice sections, connector clips, and other components required to support wall panels and other wall panel-supported construction.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install metal panel system in accordance with manufacturer's instructions and in coordination with attachment system and exposed moldings and trim.
  - 1. Position pans according to manufacturer's written instructions.
  - 2. Fit adjoining units to form flush, tight joints.
  - 3. Install directionally patterned or textured metal panels in directions indicated.

3.02 CLEANING

- A. Clean exposed surfaces of acoustical metal wall panels, including trim and edge moldings, after removing strippable, temporary protective covering, if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace wall components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

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SECTION 09 84 36 - SOUND-ABSORBING CEILING UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Shop-fabricated, fabric-wrapped, sound-absorbing panels tested for acoustical performance, including the following:
  - 1. Sound-absorbing baffle panels.

1.02 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For sound-absorbing ceiling units. Include mounting devices and details.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Maintenance data.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by approved manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Provide sound-absorbing ceiling units meeting the following requirements as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
  - 1. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    - a. Flame-Spread Index: 25 or less.
    - b. Smoke-Developed Index: 450 or less.
  - 2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 286.

2.03 SOUND-ABSORBING CEILING UNITS

- A. Sound-Absorbing Baffle Panel: Manufacturer's standard panel construction consisting of manufacturer's acoustic felt material.
  - 1. Panel Shape: As indicated on Drawings.

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2. Mounting: Top-edge mounted with manufacturer's standard suspension system , secured to substrate.
3. Nominal Overall Panel Thickness: As indicated on Drawings.
4. Panel Width: As indicated on Drawings.
5. Panel Height: As indicated on Drawings.

2.04 FABRICATION

- A. General: Use manufacturer's standard construction except as otherwise indicated.
- B. Measure each area and establish layout of panels and joints of sizes indicated on Drawings within a given area.
- C. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install sound-absorbing ceiling units in locations indicated with edges in alignment with walls and other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
- B. Comply with sound-absorbing ceiling unit manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.
- C. Align fabric pattern and grain with adjacent units.
- D. Clip loose threads; remove pills and extraneous materials.
- E. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION



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SECTION 09 91 00 - PAINTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Surface preparation and the application of paint systems on interior and exterior substrates.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
  - 2. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.

1.02 DEFINITIONS

- A. Sheen Levels:
  - 1. Flat: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
  - 2. Eggshell: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
  - 3. Satin: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
  - 4. Semi-Gloss: 35 to 70 units at 60 degrees, according to ASTM D523.
  - 5. Gloss: 70 units and greater at 60 degrees, according to ASTM D523.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
  - 1. Include preparation requirements and application instructions.
  - 2. Indicate VOC content.
- B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
  - 1. Submit Samples on rigid backing, 8 inches square.
  - 2. Apply coats on Samples in steps to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.

1.04 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for paints and coatings, indicating VOC content.

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1.05 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
    - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
    - b. Other Items: Architect will designate items or areas required.
  - 2. Final approval of color selections will be based on mockups.
    - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in other Part 3 articles for the paint category indicated.
- B. Source Limitations: Obtain products for each coating system from single source from single manufacturer.

2.02 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Paints and Coatings:
    - a. VOC content limits for field applications.

2.03 PAINT PRODUCTS, GENERAL

- A. Material Compatibility:
  - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- B. Colors: As indicated in a color schedule.

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PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
  - 1. Concrete: 12 percent.
  - 2. Masonry (Clay and CMUs): 12 percent.
  - 3. Wood: 15 percent.
  - 4. Gypsum Board: 12 percent.
  - 5. Plaster: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- F. Proceed with coating application only after unsatisfactory conditions have been corrected.
  - 1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

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- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
  - 1. SSPC-SP 3, Power Tool Cleaning."
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates:
  - 1. Metal Substrates Galvanized in Accordance with ASTM A 123 and ASTM A 153: Prepare substrates in accordance with ASTM D 6386.
  - 2. Other Galvanized Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
  - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
  - 2. Sand surfaces that will be exposed to view, and dust off.
  - 3. Prime edges, ends, faces, undersides, and backsides of wood.
  - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

### 3.03 INSTALLATION

- A. Apply paints according to manufacturer's written instructions.
  - 1. Use applicators and techniques suited for paint and substrate indicated.
  - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
  - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

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4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed in equipment rooms:
    - a. Equipment, including panelboards and switch gear.
    - b. Uninsulated metal piping.
    - c. Uninsulated plastic piping.
    - d. Pipe hangers and supports.
    - e. Metal conduit.
    - f. Plastic conduit.
    - g. Tanks that do not have factory-applied final finishes.
    - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
  2. Paint the following work where exposed in occupied spaces:
    - a. Equipment, including panelboards.
    - b. Uninsulated metal piping.
    - c. Uninsulated plastic piping.
    - d. Pipe hangers and supports.
    - e. Metal conduit.
    - f. Plastic conduit.
    - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
    - h. Other items as directed by Architect.
  3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.04 FIELD QUALITY CONTROL

- A. Dry-Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.
1. Contractor shall touch up and restore painted surfaces damaged by testing.

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2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.

3.05 CLEANING AND PROTECTION

- A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.06 INTERIOR PAINTING SCHEDULE

- A. Gypsum Board; Acrylic Latex: Provide one of the following systems:
  1. Benjamin Moore:
    - a. Primer: Ultra Spec 500 Interior Latex Primer.
    - b. Intermediate Coat: Same as top coat.
    - c. Top Coat: Ultra Spec 500 Interior.
    - d. Sheen:
      - 1) Walls: Eggshell, unless indicated otherwise.
      - 2) Ceilings: Flat, unless indicated otherwise.
  2. Sherwin Williams:
    - a. Primer: ProMar 200 Zero VOC Interior Latex Primer B28 Series.
    - b. Intermediate Coat: Same as top coat.
    - c. Top Coat: ProMar 200 Zero VOC Interior Latex.
    - d. Sheen:
      - 1) Walls: Eggshell, unless indicated otherwise.
      - 2) Ceilings: Flat, unless indicated otherwise.
  3. PPG:
    - a. Primer: Speedhide ZERO VOC Interior Latex Primer.
    - b. Intermediate Coat: Same as top coat.
    - c. Top Coat: Speedhide ZERO VOC Interior Latex.
    - d. Sheen:
      - 1) Walls: Eggshell, unless indicated otherwise.
      - 2) Ceilings: Flat, unless indicated otherwise.
- B. Wood Trim, Wood Doors, Wood Frames and Other Interior Wood and Wood-Based Items as Indicated; Acrylic Latex. Provide one of the following systems:
  1. Benjamin Moore:
    - a. Primer: Ultra Spec 500 Interior Latex Primer.
    - b. Intermediate Coat: Same as top coat.
    - c. Top Coat: Advance Waterborne Interior Alkyd.
    - d. Sheen: Semi-gloss, unless indicated otherwise.
  2. Sherwin Williams:

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- a. Primer: S-W PrepRite Multi-Purpose Latex Primer.
  - b. Intermediate Coat: Same as top coat.
  - c. Top Coat: Promar 200 WB Acrylic Alkyd.
  - d. Sheen: Semi-gloss, unless indicated otherwise.
3. PPG:
- a. Primer: Speedhide Interior Sealer Quick Drying 6-2.
  - b. Intermediate Coat: Same as top coat.
  - c. Top Coat: Speedhide Int/Ext Water Borne Alkyd.
  - d. Sheen: Semi-gloss, unless indicated otherwise.
- C. Ferrous and Non Ferrous Metals Including: Exposed metal fabrications, steel doors, steel door frames, grilles, panels, stairs, railings, and other miscellaneous metal items indicated; Direct to Metal Acrylic. Provide one of the following systems:
1. Rustoleum Sierra Performance:
- a. Primer: S-37 System Metalmax DTM Acrylic Urethane.
  - b. Intermediate Coat: None required.
  - c. Top Coat: Same as Primer.
  - d. Sheen: Semi-gloss, unless indicated otherwise.
2. Sherwin Williams:
- a. Primer: Pro Industrial ProCryl Primer B66-1300.
  - b. Intermediate Coat: None required.
  - c. Top Coat: Pro Industrial Acrylic B66-1151 Series.
  - d. Sheen: Semi-gloss, unless indicated otherwise.
3. PPG:
- a. Primer: Pitt-Tech Plus EP PRIMER Int/Ext Rust Inhibitive Primer.
  - b. Intermediate Coat: None required.
  - c. Top Coat: 90-1610 Pitt-Tech Plus EP DTM Light Industrial.
  - d. Sheen: Semi-gloss, unless indicated otherwise.
- D. Concrete and Concrete Masonry; Acrylic Latex: Provide one of the following systems:
1. Benjamin Moore:
- a. Primer:
    - 1) Concrete: Super Spec Masonry Interior/Exterior 100% Acrylic Masonry Sealer N/066.
    - 2) Concrete Masonry: Super Spec Latex Block Filler 160.
  - b. Intermediate Coat: Same as top coat.
  - c. Top Coat: Ultra Spec 500 Interior.
  - d. Sheen: Eggshell, unless indicated otherwise.
2. Sherwin Williams:
- a. Primer:
    - 1) Concrete: Loxon Concrete & Masonry Primer.
    - 2) Concrete Masonry: PrepRite Block Filler.
  - b. Intermediate Coat: Same as top coat.
  - c. Top Coat: ProMar 200 Zero VOC Eg-Shel, B20 Series.
  - d. Sheen: Eggshell, unless indicated otherwise.
3. PPG:



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- a. Primer:
    - 1) Concrete: Perma-Crete Interior/Exterior Alkali Resistant Primer.
    - 2) Concrete Masonry: Speedhide Interior/Exterior Masonry Block Filler Latex 6-7 Series.
  - b. Intermediate Coat: Same as top coat.
  - c. Top Coat: Speedhide ZERO VOC Eggshell, 6-53XX Series.
  - d. Sheen: Eggshell, unless indicated otherwise.
- E. Mechanical And Electric Equipment Items: Provide one of the following systems:
- 1. Tnemec:
    - a. One Coat: Uni-Bond DF Series 115; 3.0 DFM.
    - b. Color: White.
  - 2. PPG:
    - a. One Coat: Speedhide Super Tech Interior Dry Fog Flat 6-723XI.
    - b. Color: White.

3.07 EXTERIOR PAINTING SCHEDULE

- A. Ferrous Metal: Exposed steel members, bollards, exposed miscellaneous metal; Urethane. Provide the following system:
- 1. Tnemec:
    - a. Primer: Zinc-rich polyurethane; Hydro-Zinc 94-H20, 2.5 to 3.5 DFM.
    - b. Intermediate Coat: Polyamidoamine epoxy; Series L69 Hi-Build Epoxoline II, 4 to 6 DFM.
    - c. Top Coat: Aliphatic Acrylic Polyurethane; Series 1095 Endura-Shield, 2 to 5 DFM.
    - d. Sheen: Semi-gloss.
- B. Galvanized Metal: Exposed structural steel members, hollow metal doors and frames, railings, bollards, canopy framing, exposed miscellaneous metal; Urethane. Provide the following system:
- 1. Tnemec:
    - a. Primer: Polyamidoamine epoxy, Series L69, 4 to 6 DFM.
    - b. Intermediate Coat: Not required.
    - c. Top Coat: Aliphatic Acrylic Polyurethane; Series 1095 Endura-Shield; 2 to 5 DFM.
    - d. Sheen: Semi-gloss.
- C. Intumescent Coated Steel:
- 1. Tnemec:
    - a. Primer: None required.
    - b. Intermediate Coat: Same as top coat.
    - c. Top Coat: Aliphatic Acrylic Polyurethane; Series 1095 Endura-Shield; 2 to 5 DFM.
- D. Concrete and Concrete Masonry: Modified Waterborne Acrylate. Provide the following system:

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1. Tnemec:
  - a. Primer: Waterborne modified polyamine epoxy, 151-1051 Elasto-Grip FC, 6 mils.
  - b. Intermediate Coat: Not required.
  - c. Top Coat: High build acrylic; Enviro-Crete; 9 DFM.
  - d. Sheen: Flat.

END OF SECTION



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SECTION 10 14 00 - SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Dimensional characters.
  - 2. Panel signs.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
  - 2. Division 26 for illuminated, self-luminous, and photoluminescent exit sign units.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For signs.
  - 1. Include fabrication and installation details and attachments to other work.
  - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
  - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Product Schedule: For signs. Use same designations indicated on Drawings or specified.
- E. Delegated-Design Submittal: For signs indicated in "Performance Requirements" Article.
  - 1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for adhesives, indicating VOC content.
  - 2. Documentation for adhesives, indicating compliance with emissions testing or certification.
- B. Sample Warranty: For special warranty.

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1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.05 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Adhesives:
    - a. VOC content limits for field applications.

2.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design sign structure and anchorage of dimensional character sign type(s) according to structural performance requirements.
- B. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.
- C. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- D. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and California Building Code, Chapter 11.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.03 DIMENSIONAL CHARACTERS

- A. Cutout Characters: Characters with uniform faces; square-cut, smooth edges; precisely formed lines and profiles; and as follows:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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- a. A.R.K. Ramos.
- b. ACE Sign Systems, Inc.
- c. APCO Graphics, Inc.
- d. ASI Sign Systems, Inc.
- e. Cosco.
- f. Diskey Sign Company.
- g. Gemini Signage; Gemini, Inc.
- h. Matthews International Corporation; Bronze Division.
- i. Metal Arts.
- j. Metallic Arts.
- k. Southwell Company (The).
- l. Steel Art Company.
- m. inpro Corporation.
- 2. Character Material: Sheet or plate aluminum .
- 3. Character Height: As indicated on Drawings.
- 4. Thickness: As indicated on Drawings.
- 5. Finishes:
  - a. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color as selected by Architect from manufacturer's full range.
- 6. Mounting: As indicated on Drawings .

2.04 PANEL SIGNS

- A. Panel Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ACE Sign Systems, Inc.
    - b. Advance Corporation.
    - c. Allen Industries Architectural Signage.
    - d. Allen Markings.
    - e. APCO Graphics, Inc.
    - f. ASE, Inc.
    - g. ASI Sign Systems, Inc.
    - h. Best Sign Systems, Inc.
    - i. Bunting Graphics, Inc.
    - j. Clarke Systems.
    - k. Cosco.
    - l. Diskey Architectural Signage Inc.
    - m. Fossil Industries, Inc.
    - n. Inpro Corporation.
    - o. Mohawk Sign Systems.
    - p. Nelson-Harkins Industries.
    - q. Poblocki Sign Company, LLC.
    - r. Seton Identification Products; a Brady Corporation company.



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- s. Signs & Decal Corp.
- t. Stamprite Supersine; a division of Stamp Rite Inc.
- u. Vista System.
- v. Vomar Products, Inc.
- 2. Sign Material: As indicated on Drawings.
  - a. Surface-Applied, Flat Graphics: Applied vinyl film.
  - b. Surface-Applied, Raised Graphics: Applied polymer characters and Braille.
- 3. Mounting: As indicated on Drawings .

2.05 SIGN MATERIALS

- A. Aluminum Sheet and Plate: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- B. Aluminum Extrusions: ASTM B221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- C. Stainless-Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- D. Acrylic Sheet: ASTM D4802, Type UVF (UV filtering).
- E. Polycarbonate Sheet: Coated, mar-resistant, UV-stabilized polycarbonate, with coating on both sides.
- F. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as indicated on Drawings and suitable for exterior applications.

2.06 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:
  - 1. Use concealed fasteners and anchors unless indicated to be exposed.
  - 2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
  - 3. Exposed Metal-Fastener Components, General:
    - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
  - 4. Sign Mounting Fasteners:
    - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
    - b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.



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- c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.
- B. Adhesive: As recommended by sign manufacturer.
- C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

2.07 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
  - 1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
  - 2. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
  - 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
  - 4. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
  - 5. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.
- B. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.
- C. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
  - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
  - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
  - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

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4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Accessible Signage: Install in locations on walls as indicated on Drawings and according to the accessibility standard.
- C. Mounting Methods:
1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
    - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
    - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
  2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
    - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
    - b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.
  3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
  4. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.
  5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
  6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
- D. Remove temporary protective coverings and strippable films as signs are installed.

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SECTION 10 21 13 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Toilet compartments configured as toilet enclosures and urinal screens of the following type:
    - a. Solid-plastic.
- B. Related Sections:
  - 1. Section 10 28 00 "Toilet Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories mounted on toilet compartments.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.
- B. Shop Drawings: For toilet compartments.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Show locations of cutouts for compartment-mounted toilet accessories.
  - 3. Show locations of reinforcements for compartment-mounted grab bars and locations of blocking for surface-mounted toilet accessories.
  - 4. Show locations of centerlines of toilet fixtures.
  - 5. Show locations of floor drains.
  - 6. Show overhead support or bracing locations.
- C. Samples for Initial Selection: For each type of toilet compartment material indicated.
  - 1. Include Samples of hardware and accessories involving material and color selection.
- D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
  - 1. Each type of material, color, and finish required for toilet compartments, prepared on 6-inch- square Samples of same thickness and material indicated for Work.
  - 2. Each type of hardware and accessory.

1.03 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of toilet compartment.

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1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.05 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and California Building Code, Chapter 11 for toilet compartments designated as accessible.
- B. Fire Performance: Tested in accordance with, and pass the acceptance criteria of, NFPA 286.
- C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: 75 or less.
  - 2. Smoke-Developed Index: 450 or less.

2.02 SOLID-PLASTIC TOILET COMPARTMENTS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Scranton Products; Aria Toilet Partitions, or comparable product by one of the following:
  - 1. Accurate Partitions Corporation.
  - 2. Ampco, Inc.
  - 3. Bradley Corporation; Mills Partitions.
  - 4. Hadrian Manufacturing Inc.
  - 5. Partitions Systems Incorporated.
  - 6. Scranton Products.
  - 7. Weis-/Robart Partitions/Penner Partitions Inc.
- B. Toilet-Enclosure Style: Full-height overhead braced.
- C. Urinal-Screen Style: Wall hung.



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- D. Door, Panel, Screen, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch thick, seamless, with eased edges, no-sightline system, and with homogenous color and pattern throughout thickness of material.
  - 1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
  - 2. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum or stainless steel strip fastened to exposed bottom edges of solid-plastic components to hinder malicious combustion.
  - 3. Color and Pattern: One color and pattern in each room As indicated on Drawings.
- E. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.
- F. Brackets (Fittings):
  - 1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

## 2.03 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: Manufacturer's heavy-duty operating hardware and accessories.
  - 1. Hinges: Manufacturer's minimum 0.062-inch- thick, stainless steel continuous, cam type that swings to a closed or partially open position, allowing emergency access by lifting door. Mount with through-bolts.
  - 2. Latch and Keeper: Manufacturer's heavy-duty, surface-mounted, cast stainless steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with through-bolts.
  - 3. Coat Hook: Manufacturer's heavy-duty, combination cast stainless steel hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories. Mount with through-bolts.
  - 4. Door Bumper: Manufacturer's heavy-duty, rubber-tipped, cast stainless steel bumper at out-swinging doors. Mount with through-bolts.
  - 5. Door Pull: Manufacturer's heavy-duty cast stainless steel pull at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through-bolts.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.



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2.04 MATERIALS

- A. Aluminum Extrusions: ASTM B221.
- B. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- C. Stainless Steel Castings: ASTM A743/A743M.

2.05 FABRICATION

- A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories, and solid blocking within panel where required for attachment of toilet accessories.
- B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- C. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide, in-swinging doors for standard toilet compartments and 36-inch- wide, out-swinging doors with a minimum 32-inch- wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
  - 1. Confirm location and adequacy of blocking and supports required for installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Coordinate layout and installation of supports, inserts, and anchors built into other units of work for toilet compartment anchorage.

3.02 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position indicated with manufacturer's recommended anchoring devices.
  - 1. Maximum Clearances:
    - a. Pilasters and Panels: 1/2 inch.
    - b. Panels and Walls: 1 inch.

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2. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.
    - a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
    - b. Align brackets at pilasters with brackets at walls.
  - B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
  - C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.
- 3.03 ADJUSTING
- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION



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SECTION 10 22 39 - FOLDING PANEL PARTITIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Electrically operated, acoustical panel partitions.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
  - 2. Section 05 50 00 "Metal Fabrications" for supports that attach supporting tracks to overhead structural system.
  - 3. Electrical and communications Sections for electrical service and connections for motor operators, controls, and limit switches and for system disconnect switches.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For operable panel partitions.
  - 1. Include plans, elevations, sections, attachment details, and numbered panel installation sequence.
  - 2. Indicate stacking and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
  - 3. Include diagrams for power, signal, and control wiring.
- C. Samples: For each type of exposed material, finish, covering, or facing.
  - 1. Include Samples of accessories involving color selection.
- D. Delegated-Design Submittal: For operable panel partitions.
  - 1. Include design calculations for seismic restraints that brace tracks to structure above.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for composite wood products, indicating compliance with emissions testing or certification.
- B. Setting Drawings: For embedded items and cutouts required in other work.
- C. Seismic Qualification Certificates: For operable panel partitions, tracks, accessories, and components, from manufacturer. Include seismic capacity of partition assemblies to remain in vertical position during a seismic event and the following:

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1. Basis for Certification: Indicate whether certification is based on analysis, testing, or experience data, according to ASCE/SEI 7.
  2. Detailed description of partition anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of operable panel partition.
1. Include approval letter signed by manufacturer acknowledging Owner-furnished panel facing material complies with requirements.
- E. Product Test Reports: For each operable panel partition, for tests performed by a qualified testing agency.
- F. Field quality-control reports.
- G. Sample Warranty: For manufacturer's special warranty.
- 1.04 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For operable panel partitions to include in maintenance manuals.
1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
    - a. Panel finish facings and finishes for exposed trim and accessories. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
    - b. Seals, hardware, track, track switches, carriers, and other operating components.
    - c. Electric operator and controls.
- 1.05 QUALITY ASSURANCE
- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- 1.06 DELIVERY, STORAGE, AND HANDLING
- A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.
- 1.07 WARRANTY
- A. Special Warranty: Manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
    - a. Faulty operation of operable panel partitions.



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- b. Deterioration of metals, metal finishes, and other materials beyond normal use.
- 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Composite Wood Products:
    - a. Formaldehyde emissions testing or certification.

2.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design seismic bracing of tracks to structure above.
- B. Seismic Performance: Operable panel partitions shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the partition panels will remain in place without separation of any parts when subjected to the seismic forces specified."
- C. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:
  - 1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E90, determined by ASTM E413, and rated for not less than the STC indicated.
- D. Fire-Test-Response Characteristics: Provide panels with finishes complying with one of the following as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction:
  - 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    - a. Flame-Spread Index: 25 or less.
    - b. Smoke-Developed Index: 450 or less.
  - 2. Fire Growth Contribution: Complying with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 286.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.



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2.03 OPERABLE ACOUSTICAL PANELS

- A. Operable Acoustical Panels: Operable acoustical panel partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Modernfold, Inc.; Acousti-Seal Legacy, or comparable product by one of the following:
    - a. Advanced Equipment Corporation.
    - b. Curtition, Inc.
    - c. FolDoor; Holcomb & Hoke Mfg. Co., Inc.
    - d. Hufcor.
    - e. KWI-K-WALL Company.
    - f. Moderco Inc.
    - g. Modernfold, Inc.; a DORMA Group Company.
    - h. Panelfold Inc.
- B. Panel Operation: Electrically operated, continuously hinged panels.
- C. Panel Construction: As required to support panel from suspension components and with reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
- D. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
  - 1. Panel Width: Standard widths.
- E. STC: Not less than 52.
- F. Panel Weight: 11 lb/sq. ft. maximum.
- G. Panel Thickness: Nominal dimension of 3 inches.
- H. Panel Materials:
  - 1. Steel Frame: Steel sheet, manufacturer's standard nominal minimum thickness for uncoated steel.
  - 2. Steel Face/Liner Sheets: Tension-leveled steel sheet, manufacturer's standard minimum nominal thickness for uncoated steel.
- I. Panel Closure: Manufacturer's standard unless otherwise indicated.
- J. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.
  - 1. Hinges: Concealed (invisible).



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K. Finish Facing: Fabric wall covering.

2.04 SEALS

- A. Description: Seals that produce operable panel partitions complying with performance requirements and the following:
1. Manufacturer's standard seals unless otherwise indicated.
  2. Seals made from materials and in profiles that minimize sound leakage.
  3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.
- B. Vertical Seals: Deep-nesting, interlocking steel astragals mounted on each edge of panel, with continuous, resilient acoustical seal.
- C. Horizontal Top Seals: Continuous-contact, resilient seal exerting uniform constant pressure on track.
- D. Horizontal Bottom Seals: Resilient, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal and vertical sealing and resisting panel movement.
1. Automatically Operated for Acoustical Panels: Extension and retraction of bottom seal automatically operated by movement of partition, with operating range not less than 2 inches between retracted seal and floor finish.

2.05 PANEL FINISH FACINGS

- A. Description: Finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.
1. Apply facings free of air bubbles, wrinkles, blisters, and other defects, with edges tightly butted, and with no gaps or overlaps. Horizontal seams are not permitted. Tightly secure and conceal raw and selvage edges of facing for finished appearance.
  2. Match facing pattern 72 inches above finished floor.
- B. Fabric Wall Covering: Manufacturer's standard fabric, from same dye lot, treated to resist stains.
1. Color/Pattern: As selected by Architect from manufacturer's full range.
- C. Trimless Edges: Fabricate exposed panel edges so finish facing wraps uninterrupted around panel, covering edge and resulting in an installed partition with facing visible on vertical panel edges, without trim, for minimal sightlines at panel-to-panel joints.



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2.06 SUSPENSION SYSTEMS

- A. Tracks: Steel or aluminum with adjustable steel hanger rods for overhead support, designed for operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.
  - 1. Head Closure Trim: As required for acoustical performance; with factory-applied, decorative, protective finish.
- B. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.
- C. Steel Finish: Manufacturer's standard, factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

2.07 ELECTRIC OPERATORS

- A. Factory-assembled electric operation system of size and capacity recommended and provided by operable panel partition manufacturer for partition specified; with electric motor and factory-prewired motor controls, speed reducer, chain drive, control stations, control devices, and accessories required for operation. Include wiring from control stations to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
- B. Comply with NFPA 70.
- C. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.
- D. Motor Electrical Characteristics:
  - 1. Horsepower: Manufacturer's standard.
  - 2. Volts: 208.
  - 3. Phase: Polyphase.
  - 4. Hertz: 60.
- E. Control Stations: Two single-key-operated, constant-pressure control stations located remotely from each other on opposite sides and opposite ends of partition run. Wire in series to require simultaneous activation of both key stations to operate partition. Furnish two keys per station.
- F. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop operable panel partition at fully extended and fully stacked positions.



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- G. Electric Interlock: Equip each motorized operable panel partition with electric interlocks at locations indicated, to prevent operation of operable panel partition under the following conditions:
  - 1. On storage pocket door, to prevent operation if door is not in fully open position.
  - 2. On partitions at location of convergence by another partition, to prevent operation if merging partitions are in place.

2.08 ACCESSORIES

- A. Storage Pocket Door: Full height at end of partition runs to conceal stacked partition; of same materials, finish, construction, thickness, and acoustical qualities as panels; complete with operating hardware. Hinges in finish to match other exposed hardware.
  - 1. Manufacturer's standard method to secure storage pocket door in closed position.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine flooring, floor levelness, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable panel partitions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed in area of partition installation.
- B. Install panels in numbered sequence indicated on Shop Drawings.
- C. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.
- D. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

3.03 ADJUSTING

- A. Adjust operable panel partitions, hardware, and other moving parts to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust storage pocket doors to operate smoothly and easily, without binding or warping.



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3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable panel partitions.

END OF SECTION



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SECTION 10 28 00 - TOILET ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Washroom accessories.
  - 2. Hand dryers.

1.02 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
  - 3. Include electrical characteristics.
- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
  - 1. Identify locations using room designations indicated.
  - 2. Identify accessories using designations indicated.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Structural Performance: Design accessories and fasteners to comply with the following requirements:
  - 1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.

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2.02 WASHROOM ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:
1. AJW Architectural Products.
  2. ASI-American Specialties, Inc.
  3. Bobrick Washroom Equipment, Inc.
  4. Bradley Corporation.
  5. Brey-Krause Manufacturing Co.
  6. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.
  7. Tubular Specialties Manufacturing, Inc.
- B. Toilet Tissue (Roll) Dispenser:
1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-4288.
  2. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
  3. Mounting: Surface mounted.
  4. Operation: Noncontrol delivery with theft-resistant spindle.
  5. Capacity: Designed for 4-1/2- or 5-inch- diameter tissue rolls.
  6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
- C. Toilet Tissue (Roll) Dispenser:
1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-4388.
  2. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
  3. Mounting: Recessed.
  4. Operation: Noncontrol delivery with theft-resistant spindle.
  5. Capacity: Designed for 4-1/2- or 5-inch- diameter tissue rolls.
  6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
- D. Combination Towel (Folded) Dispenser/Waste Receptacle:
1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-3942.
  2. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
  3. Mounting: Semirecessed.
  4. Minimum Towel-Dispenser Capacity: 600 C-fold or 800 multifold paper towels.
  5. Minimum Waste-Receptacle Capacity: 12 gal..
  6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
  7. Lockset: Tumbler type for towel-dispenser compartment and waste receptacle.
- E. Soap Dispenser:
1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-4112.
  2. Description: Designed for manual operation and dispensing soap in liquid or lotion form.
  3. Mounting: Horizontally oriented, surface mounted.
  4. Capacity: 40 fl. oz.



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5. Refill Indicator: Window type.

F. Grab Bar:

1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-6806 Series.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch thick.
  - a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin).
4. Outside Diameter: 1-1/2 inches.
5. Configuration and Length: As indicated on Drawings.

G. Mirror Unit:

1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-2909 Series.
2. Frame: Stainless steel angle, 0.05 inch thick .
  - a. Corners: Manufacturer's standard.
3. Size: As indicated on Drawings.
4. Hangers: Manufacturer's standard rigid, tamper and theft resistant.

2.03 HAND DRYERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:

1. AJW Architectural Products.
2. American Dryer, Inc.
3. ASI-American Specialties, Inc.
4. Bobrick Washroom Equipment, Inc.
5. Bradley Corporation.
6. Dyson Inc.
7. Excel Dryer Inc.
8. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.
9. Mitsubishi Electric US, Inc.
10. Saniflow Corporation; Mediclinics S.A.
11. Sloan Valve Company.
12. World Dryer Corporation (Zurn Industries).

B. Warm-Air Dryer:

1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-7179.
2. Description: Standard-speed, warm-air hand dryer.
3. Mounting: Surface mounted.
  - a. Protrusion Limit: Installed unit protrudes maximum 4 inches from wall surface.
4. Operation: Infrared-sensor activated with timed power cut-off switch.
  - a. Automatic Shutoff: At 85 seconds.
5. Cover Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).



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2.04 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to comply with specified structural-performance requirements.

3.02 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

END OF SECTION



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SECTION 10 41 00 - EMERGENCY ACCESS AND INFORMATION CABINETS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Key lock boxes.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.01 KEY LOCK BOXES

- A. Key Lock Boxes: Designed for storage of 10 keys.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
    - a. Knox Company; KnoxBox 3200 Standard Capacity.
  - 2. Mounting: As indicated on Drawings.
  - 3. Door Lock: Prepared to receive key from authorized agencies.
  - 4. Exposed Material and Finish: Steel, as follows:
    - a. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Examine walls for suitable framing depth and blocking where recessed key lock boxes will be installed and prepare recesses as required by type and size of lock box and trim style.

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- B. Install key lock boxes in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

3.02 FIELD QUALITY CONTROL

- A. Arrange for agency personnel to examine and test key lock boxes after they have been installed.

END OF SECTION

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SECTION 10 44 00 - FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Fire-protection cabinets for the following:
    - a. Portable fire extinguisher.
  - 2. Portable fire extinguishers.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.
  - 2. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher.
  - 3. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.
- B. Shop Drawings: For fire-protection cabinets.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of exposed finish required.

1.03 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.04 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

1.05 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Six years from date of Substantial Completion.

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PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.
- B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.03 FIRE-PROTECTION CABINET

- A. Basis-of-Design Product: Safety One; EL-Elite Architectural Series Fire Extinguisher Cabinets.
- B. Cabinet Type: Suitable for fire extinguisher.
- C. Cabinet Construction: Nonrated.
- D. Cabinet Material: Cold-rolled steel sheet.
- E. Recessed Cabinet:
  - 1. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
- F. Cabinet Trim Material: Steel sheet.
- G. Door Material: Stainless steel sheet.
- H. Door Style: Fully glazed panel with frame.
- I. Door Glazing: Tempered float glass (clear).
- J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
  - 1. Provide ADA recessed door pull.

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K. Accessories:

1. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
  - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
    - 1) Lettering Color: Red.
    - 2) Orientation: Vertical.

L. Materials:

1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
  - a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
  - b. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - c. Color: As selected by Architect from manufacturer's full range.
2. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304.
  - a. Finish: ASTM A480/A480M No. 4 directional satin finish, .
3. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.04 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet indicated.
1. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
  2. Valves: Manufacturer's standard.
  3. Handles and Levers: Manufacturer's standard.
  4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type: UL-rated 3A:40-B: C, 5 lb nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.05 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
1. Weld joints and grind smooth.
  2. Miter corners and grind smooth.
  3. Provide factory-drilled mounting holes.
- B. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

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2.06 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare recesses for recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.03 INSTALLATION

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
  - 1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semirecessed fire-protection cabinets.
  - 2. Provide inside latch and lock for break-glass panels.
  - 3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- C. Identification:
  - 1. Apply at locations indicated.



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3.04 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION



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SECTION 10 82 00 - GRILLES AND SCREENS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Fixed, formed-metal screens.
  - 2. Fixed, extruded aluminum sunshade screens.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include fabrication and installation layouts of grille and screen panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
- C. Samples: For each type of metal finish required.

1.03 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design grilles and screens and support system, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.
- B. Structural Performance: Grilles and screens shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
  - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
  - 2. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- C. Seismic Performance: Grilles and screens, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

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- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.02 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. Provide materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.03 Materials

- A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
- B. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.
- C. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- D. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.
- E. Fasteners: Use types and sizes to suit unit installation conditions.
  - 1. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
  - 2. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
  - 3. Dissimilar Metals: Type 304 stainless-steel fasteners.
  - 4. For color-finished screens, use fasteners with heads that match color of screen.
- F. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.04 FORMED-METAL SCREENS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Cascade Rooftop Screens, Inc; Style A Louver Screen, or comparable product by approved manufacturer.
- B. Fixed Screens:
  - 1. Screen Louver Depth: 2.815 inches.

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2. Form louvers attachment base from galvanized steel sheet not less than 0.052 inch thick, and facing clip from steel sheet not less than 0.028 inch thick with fluoropolymer finish.
  - a. Finish Color: As selected by Architect from manufacturer's full range.

2.05 EXTRUDED ALUMINUM SUNSHADE SCREENS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; Linear Sunshades, or comparable product by approved manufacturer.
  1. Profile: Long-Span Airfoil.
  2. Size: 6-inch.
  3. Mounting: As indicated on Drawings.
  4. Finish: High-performance organic finish.

2.06 ALUMINUM FINISHES

- A. High-Performance Organic Finish: 2 -coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  1. Color and Gloss: As selected by Architect from manufacturer's full range.

2.07 GALVANIZED-STEEL SHEET FINISHES

- A. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and repair according to ASTM A 780.
- B. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat.
  1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Attachment Assembly, General: Install attachment assembly required to support grilles and screens including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
  1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.



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- B. Install support assembly at locations, spacings, and with fasteners recommended by manufacturer. Use manufacturer's standard horizontal and vertical members that provide support and secondary drainage assembly, draining to the exterior at horizontal joints.
  - 1. Install grille and screen panels to allow individual panels to be installed and removed without disturbing adjacent panels.
- C. Provide anchorage devices and fasteners where needed to secure to in-place construction.
- D. Perform cutting, drilling, and fitting required. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.
- F. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
- G. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory and refinish entire unit or provide new units.
- H. Protect galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint.

### 3.02 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align grille and screen units within installed tolerance of 1/4 inch in 20 feet, non-accumulative, on level, plumb, and location lines as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

### 3.03 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as units are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, clean finished surfaces as recommended by manufacturer. Maintain in a clean condition during construction.

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- B. Replace grilles and screens that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION



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SECTION 11 40 00 - FOODSERVICE EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Fabricated equipment.
  - 2. Cooking equipment.
  - 3. Self-contained refrigeration equipment.
  - 4. Serving equipment.

1.02 COORDINATION

- A. Coordinate foodservice equipment layout and installation with other work, including layout and installation of lighting fixtures, HVAC equipment, and fire-suppression system components.
- B. Coordinate locations and requirements of utility service connections.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include the following:
    - a. Manufacturer's model number.
    - b. Accessories and components that will be included for Project.
    - c. Clearance requirements for access and maintenance.
    - d. Utility service connections for water, drainage, power, and fuel; include roughing-in dimensions.
- B. Shop Drawings: For fabricated equipment.
  - 1. Include plans, elevations, sections, roughing-in dimensions, fabrication details, utility service requirements, and attachments to other work.
- C. Samples for Verification: For each factory-applied color finish required, in manufacturer's standard sizes.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For foodservice equipment to include in emergency, operation, and maintenance manuals. Include the following:
  - 1. Product Schedule: For each foodservice equipment item, include the following:
    - a. Designation indicated on Drawings.
    - b. Manufacturer's name and model number.
    - c. List of factory-authorized service agencies including addresses and telephone numbers.

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1.05 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of construction contiguous with foodservice equipment by field measurements before fabrication. Indicate measurements on Coordination Drawings.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. NSF Standards: Provide equipment that bears NSF Certification Mark or UL Classification Mark certifying compliance with applicable NSF standards.
- B. UL Certification: Provide electric and fuel-burning equipment and components that are evaluated by UL for fire, electric shock, and casualty hazards according to applicable safety standards, and that are UL certified for compliance and labeled for intended use.
- C. Regulatory Requirements: Install equipment to comply with the following:
  - 1. NFPA 70, "National Electrical Code."

2.02 FABRICATED EQUIPMENT

- A. Stainless Steel Sinks:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide John BOOS; 2B-1D B-Series Sinks, or comparable product by an approved manufacturer.
  - 2. Description: Two -compartment sink(s). Fabricate units of welded stainless steel, sound deadened.
    - a. Bowls: Stainless steel, Type 304, [0.078 inch] [0.062 inch] thick.
    - b. Integral Drainboards: Stainless steel, Type 304, [0.078 inch] [0.062 inch] thick.
    - c. Body: Stainless steel, Type 304, 0.062 inch thick.
      - 1) Back Splash: Manufacturer's standard height.
    - d. Legs and Feet: Stainless steel tubing legs with adjustable bullet feet.
  - 3. Stainless Steel Sheet: ASTM A240/A240M, austenitic stainless steel, type as indicated.
  - 4. Stainless Steel Finish: Directional satin finish, ASTM A480/A480M, No. 4.

2.03 COOKING EQUIPMENT

- A. Ranges:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide KoolMore; KM-CR60-E or comparable product by an approved manufacturer.
  - 2. Description:
    - a. Top Configuration:
      - 1) Open-Burner Unit:

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- a) Standard Burners: 10.
- b. Base Configuration:
  - 1) Standard Oven(s): Two.
- c. Accessories:
  - 1) High back shelf.
  - 2) Oven Rack(s): Two for each oven.
- d. Electrical Service: Equip unit for connection to service indicated on Drawings.

2.04 SELF-CONTAINED REFRIGERATION EQUIPMENT

- A. Refrigeration Equipment: Refrigerators.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Atosa; MBF8507GR, or comparable product by an approved manufacturer.
  - 2. Description: Reach-in type.
    - a. Exterior Finish: Stainless steel.
    - b. Interior Finish: Stainless steel.
    - c. Electrical Service: Equip unit with plug and cord for service indicated on Drawings.
- B. Refrigeration Equipment: Freezers.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Arctic Air; AF49, or comparable product by an approved manufacturer.
  - 2. Description: Reach-in type.
    - a. Exterior Finish: Stainless steel.
    - b. Interior Finish: Manufacturer's standard.
    - c. Electrical Service: Equip unit with plug and cord for service indicated on Drawings.
- C. Ice-Making Machine:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Manitowoc Ice; Indigo NXT Series iT0450 Ice Machine, or comparable product by an approved manufacturer.
  - 2. Description: Freestanding units.
    - a. Production: Ice cubes, half-dice.
    - b. Capacity: 490 lbs per 24-hour period.
    - c. Accessories:
      - 1) Storage Bin: Model D-400.
        - a) Storage Capacity: 365 lbs.
      - 2) Stainless steel stand and legs.
      - 3) Water filter.
    - d. Electrical Service: Equip unit for connection to service indicated on Drawings.

2.05 SERVING EQUIPMENT

- A. Holding Cabinet:

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1. Basis-of-Design Product: Subject to compliance with requirements, provide CresCor; Model H-137-SUA-12D, or comparable product by an approved manufacturer.
2. Description: Hot food, insulated holding cabinet.
  - a. Finish: Stainless steel.
  - b. Accessories:
    - 1) Casters.
    - 2) Smooth interior coved corners.
    - 3) Reversible Dutch doors.
    - 4)
  - c. Electrical Service: Equip unit for connection to service indicated on Drawings.

2.06 MISCELLANEOUS MATERIALS

- A. Installation Accessories, General: NSF certified for end-use application indicated.

2.07 FINISHES

- A. Stainless Steel Finishes:
  1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
  2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
    - a. Run grain of directional finishes with long dimension of each piece.
    - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install foodservice equipment level and plumb, according to manufacturer's written instructions.
  1. Connect equipment to utilities.
  2. Provide cutouts in equipment, neatly formed, where required to run service lines through equipment to make final connections.
- B. Complete equipment assembly where field assembly is required.
  1. Provide closed butt and contact joints that do not require a filler.
  2. Grind field welds on stainless steel equipment until smooth and polish to match adjacent finish.
- C. Install equipment with access and maintenance clearances that comply with manufacturer's written installation instructions and with requirements of authorities having jurisdiction.



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- D. Install joint sealant in joints between equipment and abutting surfaces with continuous joint backing unless otherwise indicated. Produce airtight, watertight, vermin-proof, sanitary joints.

3.02 CLEANING AND PROTECTING

- A. After completing installation of equipment, repair damaged finishes.
- B. Clean and adjust equipment as required to produce ready-for-use condition.
- C. Protect equipment from damage during remainder of the construction period.

3.03 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain foodservice equipment.

END OF SECTION



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SECTION 11 81 29 - FACILITY FALL PROTECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Roof -mounted tie off anchors.

1.02 COORDINATION

- A. Coordinate layout and installation of fall protection equipment with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of fall protection equipment component.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings:
  - 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions.

1.04 INFORMATIONAL SUBMITTALS

- A. Delegated-Design Submittal: For fall protection equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
- B. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
  - 1. Size and location of fall protection equipment specified in this Section.
  - 2. Method of attaching fall protection equipment to roof or building structure.
  - 3. Required clearances.
- C. Sample Warranties: For manufacturer's special warranties.



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1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fall protection equipment to include in operation and maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Where fabrications are specified to comply with specific structural performance requirements, provide design sealed by a professional engineer registered in The State of California.
- B. Comply with the following OSHA regulations:
  - 1. 1910, Subpart D (Walking and Working Surfaces).
  - 2. Appendix C to 1910 Subpart F (Personal Fall Arrest Systems).
- C. Comply with the following California State regulations:
  - 1. Code of Regulations, Title 8-Industrial Relations, Article 5 (Window Cleaning), and Appendix C to Article 6 (Personal Fall Arrest System).

1.07 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Tie-Off Anchors:
    - a. Atlas Anchor Systems.
    - b. Guardian.
    - c. Probel.
    - d. Rooftop Anchor, Inc.
- B. Source Limitations: Obtain fall protection systems and components from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. General Performance: Fall protection equipment shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

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- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design fall protection equipment to comply with performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Structural Performance: Fall protection components shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
  - 1. Design Loads:
    - a. Fall Arrest Force: Maximum 1,800 lbs when wearing a body harness with a safety factor of 2 without any permanent deformation.
    - b. Anchor Points: Capable of supporting 5,000 lbs per person attached.

2.03 TIE-OFF ANCHORS

- A. Roof -Mounted Anchors: Metal anchors capable of meeting performance requirements; with welded joints, and integrally formed structure-mounting base for attachment to substrate.
- B. Material: Zinc-coated (galvanized) steel.
  - 1. Finish: Mill phosphatized.
- C. Construction:
  - 1. Anchor Cap: Provide weathertight platform cap.
  - 2. Metal Counterflashing: Manufacturer's standard, removable, fabricated of sheet metal of same metal and finish as anchor.
  - 3. On ribbed or fluted metal roof deck, provide deck-mounting base plate as required by manufacturer.
  - 4. Fabricate anchors to minimum height of 12 inches above roofing surface unless otherwise indicated.

2.04 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation.
  - 1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
- B. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.
- C. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.
- D. Steel Pipe: ASTM A53/A53M, galvanized.

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2.05 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- C. Fasteners: Fall protection equipment component manufacturer's recommended fasteners suitable for application and metals being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
  - 1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
- D. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant as recommended by fall protection equipment component manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install fall protection equipment according to manufacturer's written instructions.
  - 1. Install fall protection equipment level; plumb; true to line and elevation.
  - 2. Anchor fall protection equipment components securely in place so they are capable of resisting indicated loads.
  - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of fall protection equipment components.
  - 4. Install fall protection equipment to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.



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- C. Preformed Flashing-Sleeve Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to roof membrane manufacturer's instructions.

END OF SECTION



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SECTION 12 24 13 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes motor- operated roller shades for windows .

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
  - 1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified, 10 inches long.
- D. Product Schedule: For roller shades. Use same designations indicated on Drawings.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of shadeband material.
- C. Product Test Reports: For each type of shadeband material, for tests performed by a qualified testing agency.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.



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1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.07 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. BTX Window Automation, Inc.
  - 2. DFB Sales.
  - 3. Draper Inc.
  - 4. Hunter Douglas Contract.
  - 5. Lutron Electronics Co., Inc.
  - 6. MechoShade Systems, Inc.
  - 7. Nysan Solar Control Inc.; Hunter Douglas Company.
  - 8. OEM Shades Inc.
  - 9. Shade Techniques, LLC.
  - 10. Silent Gliss USA, Inc.
  - 11. SM Automatic, Inc.
- B. Source Limitations: Obtain roller shades from single source from single manufacturer.



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2.02 MOTOR-OPERATED, SINGLE-ROLLER SHADES

- A. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
  - 1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Electric Motor: Manufacturer's standard tubular, enclosed in roller.
    - a. Maximum Total Shade Width: As required to operate roller shades indicated.
    - b. Maximum Shade Drop: As required to operate roller shades indicated.
    - c. Maximum Weight Capacity: As required to operate roller shades indicated.
  - 3. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
  - 1. Shadeband-to-Roller Attachment: Manufacturer's standard method .
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers that are operated by one roller drive-end assembly.
- E. Shadebands:
  - 1. Shadeband Material: Light-filtering fabric.
  - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
    - a. Type: Enclosed in sealed pocket of shadeband material.
- F. Installation Accessories:
  - 1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
    - a. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 3 inches.
  - 2. Installation Accessories Color and Finish: As selected from manufacturer's full range.



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2.03 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
- C. Basis-of-Design Product: As indicated on Drawings.
  - 1. Orientation on Shadeband: As indicated on Drawings.
  - 2. Color: As indicated on Drawings.

2.04 ROLLER SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
  - 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
  - 2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:
  - 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
  - 2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.



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PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, locations of connections to building electrical system, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.
- C. Roller Shade Locations: As indicated on Drawings.

3.03 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.04 CLEANING AND PROTECTION

- A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION

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ROLLER WINDOW SHADES  
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SECTION 12 35 59 - DISPLAY CASEWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Display casework of the following types:
  - 1. Wood-veneer-faced display shelving.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
  - 2. Section 06 41 00 "Architectural Wood Casework" for custom-fabricated shelving and architectural casework.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and details.
- C. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for composite wood products, indicating compliance with emissions testing or certification.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.05 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install wood shelving until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

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PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Composite Wood Products:
    - a. Formaldehyde emissions testing or certification.

2.02 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Display casework systems are to withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. Loads as indicated on Drawings.

2.03 WOOD-VENEER-FACED DISPLAY SHELVING

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by approved manufacturer.
- B. Wood Veneer Display Shelving System: Shelving system consisting of extruded aluminum upright frame made to receive adjustable shelves and other accessories.
  - 1. Upright Frame Units:
    - a. Type: Floor to wall units; electrified.
  - 2. Adjustable Wood-Veneer-Faced Wood Shelves: Medium-density fiberboard core with wood veneer facing.
    - a. Configuration: Wood shelf over support bar; reversible lip to be used as shelf or tray.
    - b. Include LED lighting strip along bottom side of support bar.
    - c. Colors and Finishes: As indicated by manufacturer's designations.
  - 3. Accessories:
    - a. Hang Rail: Straight hang rail spanning between uprights with LED strip light along bottom side.

2.04 MATERIALS

- A. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
  - 1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
- B. Veneer-Faced Panels: HPVA HP-1, with face veneer of species indicated, with Grade A faces.
  - 1. Face Veneer Species and Cut: Rift cut white oak.
- C. Extruded-Aluminum Bars and Shapes: ASTM B221 (ASTM B221M), Alloy 6063.

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2.05 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.06 ALUMINUM FINISHES

- A. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
  - 1. Color: Black.

2.07 WOOD FINISHES

- A. Finishing: Apply manufacturer's standard, baked, clear finish, consisting of a sealer and a conversion varnish or nitrocellulose lacquer or UV-curing resin topcoat. Sand and wipe clean between applications of sealer and topcoat.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install display casework systems at locations indicated on Drawings and according to manufacturer's written instructions.
- B. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
- C. Install type of shelves at locations indicated and at spacing indicated or, if not indicated, at equal spacing in each unit.

3.03 CLEANING AND PROTECTING

- A. Repair or remove and replace defective work as directed on completion of installation.
- B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- C. Protect installed products from damage during remainder of the construction period.

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END OF SECTION

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SECTION 12 36 00 - COUNTERTOPS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Quartz agglomerate countertops.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include plans, sections, details, and attachments to other work. Detail fabrication and installation, including field joints.
  - 2. Show locations and sizes of cutouts and holes for items installed in countertops.
- C. Samples for Verification: As follows:
  - 1. Countertops: For each type, color, pattern, and surface finish required, 12 by 12 inches in size.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for adhesives, indicating VOC content.
  - 2. Documentation for composite wood products, indicating compliance with emissions testing or certification.
- B. Product Certificates: For the following:
  - 1. Composite wood products.
  - 2. Adhesives.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

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1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- B. Quality Standard: Unless otherwise indicated, comply with WI's North American Architectural Woodwork Standards (NAAWS) for grades indicated for construction, finishes, installation, and other requirements.
  - 1. Where the Contract Documents contain requirements that are more stringent than the referenced quality standard, comply with requirements of the Contract Documents in addition to those of the referenced quality standard.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver countertops only after casework and supports on which they will be installed have been completed in installation areas.
- B. Store countertops in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
- C. Keep surfaces of countertops covered with protective covering during handling and installation.

1.07 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Field Measurements: Where countertops are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
  - 1. Adhesives:
    - a. VOC content limits for field applications.
  - 2. Composite Wood Products:
    - a. Formaldehyde emissions testing or certification.

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2.02 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS

- A. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with ICPA SS-1, except for composition.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by approved manufacturer.
  - 2. Colors and Patterns: As indicated by manufacturer's designations.

2.03 WOOD MATERIALS

- A. Plywood Subtops: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.04 QUARTZ AGGLOMERATE COUNTERTOP FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the WI's "North American Architectural Woodwork Standards."
  - 1. Grade: Custom.
- B. Configuration: As indicated on Drawings.
- C. Countertops: 3/4-inch- thick, quartz agglomerate with front edge built up with same material.
- D. Backsplashes: 3/4-inch- thick, quartz agglomerate.
- E. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
- F. Joints: Fabricate countertops without joints.
- G. Cutouts and Holes:
  - 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
  - 2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
  - 3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.



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PART 3 - EXECUTION

3.01 PREPARATION

- A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.
- B. Before installing countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing.

3.02 QUARTZ AGGLOMERATE COUNTERTOP INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. Secure countertops to subtops with adhesive according to manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- D. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- E. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- F. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- G. Apply sealant to gaps at walls; comply with Section 07 92 00 "Joint Sealants."

3.03 ADJUSTING AND CLEANING

- A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects. Where not possible to repair, replace countertops. Adjust joinery for uniform appearance.

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- B. Clean countertops on exposed and semiexposed surfaces.
- C. Protection: Provide Kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of 48 inches o.c. Remove protection at Substantial Completion.

END OF SECTION



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SECTION 12 48 13 - ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Resilient-tile entrance mats.

1.02 SUBMITTALS

- A. Product Data: For each type of floor mat and frame.
- B. Shop Drawings: Show the following:
  - 1. Items penetrating floor mats and frames, including door control devices.
  - 2. Divisions between mat sections.
  - 3. Perimeter floor moldings and frames.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Maintenance data.

1.03 QUALITY ASSURANCE

- A. Accessibility Standard: Comply with applicable provisions in the DOJ's "ADA Standards for Accessible Design" and California Building Code, Chapter 11.

PART 2 - PRODUCTS

2.01 RESILIENT-TILE ENTRANCE MATS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Amarco Products.
  - 2. Cactus Mat Mfg. Co.
  - 3. Consolidated Plastics Company, Inc.
  - 4. Durable Corporation.
  - 5. Entrance Inc.
  - 6. Matco International.
  - 7. Mats, Inc.
  - 8. Musson Rubber Co.
  - 9. Pawling Corporation.
  - 10. Turtle Plastics.

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- B. Carpet-Type Tiles: Carpet bonded to 1/8- to 1/4-inch- thick, flexible vinyl backing to form mats 3/8 or 7/16 inch thick with nonraveling edges.
  - 1. Colors, Textures, and Patterns: As indicated by manufacturer's designations.
  - 2. Tile Size: As indicated.

2.02 FABRICATION

- A. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install surface-type units to comply with manufacturer's written instructions; coordinate with entrance locations and traffic patterns.

3.02 PROTECTION

- A. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION

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## **SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

#### **1.3 COORDINATION**

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL MOTOR REQUIREMENTS**

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

#### **2.2 MOTOR CHARACTERISTICS**

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.



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- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

## 2.3 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
  - 1. Permanent-split capacitor.
  - 2. Split phase.
  - 3. Capacitor start, inductor run.
  - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

## PART 3 - EXECUTION (NOT APPLICABLE)

## END OF SECTION 22 05 13



## **SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Packless expansion joints.
2. Grooved-joint expansion joints.
3. Alignment guides and anchors.

#### **1.2 ACTION SUBMITTALS**

**A. Product Data:** For each type of product.

**B. Delegated Design Submittals:** For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

#### **1.3 INFORMATIONAL SUBMITTALS**

**A. Welding certificates.**

#### **1.4 CLOSEOUT SUBMITTALS**

**A. Maintenance Data:** For expansion joints.

#### **1.5 QUALITY ASSURANCE**

**A. Welding Qualifications:** Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.



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- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings.

### 2.2 PACKLESS EXPANSION JOINTS

- A. Flexible-Hose Packless Expansion Joints: **FHEJ-01**
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Flex-Hose Co., Inc.
    - b. Flexicraft Industries.
    - c. Flex-Pression.
    - d. Mason Industries, Inc.
    - e. Metraflex Company (The).
    - f. Unisource Manufacturing, Inc.
  - 2. Source Limitations: Obtain flexible-hose packless expansion joints from single manufacturer.
  - 3. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
  - 4. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
  - 5. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with solder-joint end connections.
    - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 340 psig at 450 deg F (2340 kPa at 232 deg C) ratings.
  - 6. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with threaded or flanged end connections.
    - a. Stainless steel hoses and single-braid, stainless steel sheaths with 300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.



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7. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Carbon steel fittings with threaded end connections.
  - a. Stainless steel hoses and single-braid, stainless steel sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 325 psig at 600 deg F (2250 kPa at 315 deg C) ratings.
8. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Carbon steel fittings with flanged or welded end connections.
  - a. Stainless steel hoses and single-braid, stainless steel sheaths with 200 psig at 70 deg F (1380 kPa at 21 deg C) and 145 psig at 600 deg F (1000 kPa at 315 deg C) ratings.

## 2.3 GROOVED-JOINT EXPANSION JOINTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Anvil International.
  2. Shurjoint-Apollo Piping Products USA Inc.
  3. Victaulic Company.
- B. Indicate on Drawings the number of couplings or amount of expansion required.
- C. Source Limitations: Obtain grooved-joint expansion joints from single manufacturer.
- D. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
- E. Standard: AWWA C606, for grooved joints.
- F. Nipples: Galvanized, ASTM A53/A53M, Schedule 40, Type E or S, steel pipe with grooved ends.
- G. Couplings: Five, flexible type for steel-pipe dimensions. Include ferrous housing sections, EPDM rubber gasket suitable for cold and hot water, and bolts and nuts.

## 2.4 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Adesco Manufacturing LLC.
    - b. Advanced Thermal Systems, Inc.
    - c. Flex-Hose Co., Inc.



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- d. Flexicraft Industries.
  - e. Flex-Weld, Inc.
  - f. Hyspan Precision Products, Inc.
  - g. Mason Industries, Inc.
  - h. Metraflex Company (The).
  - i. Senior Flexonics Pathway.
  - j. U.S. Bellows, Inc.
  - k. Unisource Manufacturing, Inc.
- 2. Source Limitations: Obtain alignment guides from single manufacturer.
  - 3. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:

- 1. Steel Shapes and Plates: ASTM A36/A36M.
- 2. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
- 3. Washers: ASTM F844, steel, plain, flat washers.
- 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Stud: Threaded, zinc-coated carbon steel.
  - b. Expansion Plug: Zinc-coated carbon steel.
  - c. Washer and Nut: Zinc-coated carbon steel.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF EXPANSION JOINTS - GENERAL

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.

### 3.2 INSTALLATION OF GROOVED-JOINT EXPANSION JOINTS

- A. Install grooved-joint expansion joints to grooved-end steel piping.

### 3.3 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.



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- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
  - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
  - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
  - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
  - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
  - 3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

#### 3.4 INSTALLATION OF PIPE LOOP AND SWING CONNECTIONS

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

**END OF SECTION 22 05 16**



## **SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Sleeves.
  - 2. Sleeve-seal systems.
  - 3. Sleeve-seal fittings.
  - 4. Grout.
  - 5. Silicone sealants.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
  - 1. Product Data: For sealants, indicating VOC content.
  - 2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

### **PART 2 - PRODUCTS**

#### **2.1 SLEEVES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Advance Products & Systems, Inc.



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2. CALPICO, Inc.
  3. GPT; an EnPro Industries company.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.
- D. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

## 2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
  2. CALPICO, Inc.
  3. GPT; an EnPro Industries company.
  4. Metraflex Company (The).
  5. Proco Products, Inc.
- B. Description:
1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
  2. Designed to form a hydrostatic seal of 20 psig (137 kPa) minimum.
  3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  4. Pressure Plates: Stainless steel.
  5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

## 2.3 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Advance Products & Systems, Inc.
  2. CALPICO, Inc.
  3. GPT; an EnPro Industries company.
  4. Metraflex Company (The).
  5. Proco Products, Inc.



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- C. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.
- D. Plastic or rubber waterstop collar with center opening to match piping OD.

## 2.4 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.5 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. GE Construction Sealants; Momentive Performance Materials Inc.
    - b. Permthane®/Acryl-R®; ITW Polymers Sealants North America.
    - c. Polymeric Systems, Inc.
    - d. Sherwin-Williams Company (The).
    - e. The Dow Chemical Company.
  - 2. Verify sealant has a VOC content of **250** g/L or less.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. May National Associates, Inc.; a subsidiary of Sika Corporation.
  - 2. Verify sealant has a VOC content of **250** g/L or less.
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.



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1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Smooth-On.
2. Verify sealant has a VOC content of **250** g/L or less.

### PART 3 - EXECUTION

#### 3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
  1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  1. Cut sleeves to length for mounting flush with both surfaces.
  2. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
  1. Cut sleeves to length for mounting flush with both surfaces.
  2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
  3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

#### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.



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- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### 3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Use grout or silicone sealant to seal the space around outside of sleeve-seal fittings.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  - 1. Exterior Concrete Walls above Grade:
    - a. Piping Smaller Than NPS 6 (DN 150): Sleeve-seal fittings.
  - 2. Concrete Slabs-on-Grade:
    - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron pipe sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
  - 3. Concrete Slabs above Grade:
    - a. Piping Smaller Than NPS 6 (DN 150): Steel pipe sleeves.
    - b. Piping NPS 6 (DN 150) and Larger: Steel pipe sleeves.



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4. Interior Partitions:
  - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel sheet sleeves.
  - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel sheet sleeves.

**END OF SECTION 22 05 17**



## **SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Escutcheons.
  - 2. Floor plates.

#### **1.3 DEFINITIONS**

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed and salvaged, or removed and reinstalled.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. BrassCraft Manufacturing Co.; a Masco company.
  - 2. Dearborn Brass.
  - 3. Jones Stephens Corp.
  - 4. Keeney Manufacturing Company (The).
  - 5. Mid-America Fittings, Inc.
  - 6. ProFlo; a Ferguson Enterprises, Inc. brand.



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## 2.2 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed and exposed-rivet hinge; and spring-clip fasteners.

## 2.3 FLOOR PLATES

- A. Split Floor Plates: Cast brass with concealed hinge.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping :
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
    - b. Chrome-Plated Piping: One-piece steel cast brass or split-casting brass with polished, chrome-plated finish.
    - c. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel; split-plate, stamped steel with concealed hinge; or split-plate, stamped steel with exposed-rivet hinge; with polished, chrome-plated finish.
    - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel; split-plate, stamped steel with concealed hinge; or split-plate, stamped steel with exposed-rivet hinge; with polished, chrome-plated finish.
    - f. Bare Piping in Unfinished Service Spaces: One-piece stamped steel; split-plate, stamped steel with concealed hinge; or split-plate, stamped steel with exposed-rivet hinge; with polished, chrome-plated finish.



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- g. Bare Piping in Equipment Rooms: One-piece stamped steel; split-plate, stamped steel with concealed hinge; or split-plate, stamped steel with exposed-rivet hinge; with polished, chrome-plated finish.
  - C. Install floor plates for piping penetrations of equipment-room floors.
  - D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
    - 1. New Piping: One-piece, floor plate.
- 3.2 FIELD QUALITY CONTROL
- A. Using new materials, replace broken and damaged escutcheons and floor plates.

**END OF SECTION 22 05 18**



## **SECTION 22 05 23.12 - BALL VALVES FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Bronze ball valves.

#### **1.2 DEFINITIONS**

- A. CWP: Cold working pressure.
- B. RPTFE: Reinforced polytetrafluoroethylene.
- C. WOG: Water, oil, gas.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of valve.

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, and soldered ends.
  - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.



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PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic water valves intended to convey or dispense water for human consumption must comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or must be certified to be in compliance with NSF 61 and NSF 372 (by an ANSI-accredited third-party certification body) that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast copper solder-joint connections.
6. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
7. ASME B16.34 for flanged and threaded end connections
8. ASME B31.9 for building services piping valves.

- C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

- E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Type:

1. Gear Actuator: For quarter-turn valves **NPS 4 (DN 100)** and larger.
2. Hand Lever: For quarter-turn valves smaller than **NPS 4 (DN 100)**.

G. Valves in Insulated Piping:

1. Provide 2-inch (50-mm) extended neck stems.



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2. Extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

## 2.3 BRONZE BALL VALVES

### A. Bronze Ball Valves, Two Piece with Full Port, and Bronze or Brass Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. Hammond Valve.
  - c. Milwaukee Valve Company.
  - d. NIBCO INC.
  - e. WATTS.
2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig (4140 kPa).
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered.
7. Seats: PTFE.
8. Stem: Bronze or brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

### B. Bronze Ball Valves, Two Piece with Full Port, and Bronze or Brass Trim, Press Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. Hammond Valve.
  - c. Milwaukee Valve Company.
  - d. NIBCO INC.
  - e. Viega LLC.
2. Standard: MSS SP-110; MSS SP-145; IAPMO/ANSI Z1157.
3. CWP Rating: Minimum 200 psig (1380 kPa).
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Press.
7. Press-End Connections Rating: Minimum 200 psig (1380 kPa).
8. Seats: PTFE or RTPFE.
9. Stem: Bronze or brass.
10. Ball: Chrome-plated brass.
11. Port: Full.



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12. O-Ring Seal: EPDM or Buna-N.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

#### 3.2 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.
- B. Provide support to piping adjacent to valves such that no force is imposed upon valves.
- C. Locate valves for easy access.
- D. For valves in horizontal piping, install valves with stem at or above center of pipe.
- E. Install valves in position to allow full valve actuation movement.
- F. Valve Tags: Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
- G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.



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3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, provide the same types of valves with higher CWP ratings.
- B. Select valves with the following end connections:
  - 1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
  - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 (DN 50) and Smaller:
  - 1. Bronze ball valves, two piece with full port, and bronze or brass trim. Provide with threaded solder or press-connection-joint ends.
- B. Pipe NPS 2-1/2 (DN 65) and Larger:
  - 1. Bronze ball valves, two piece with full port, and bronze or brass trim. Provide with threaded solder or press-connection-joint ends.

**END OF SECTION 22 05 23.12**



## **SECTION 22 05 23.13 - BUTTERFLY VALVES FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Iron, single-flange (lug-type) butterfly valves.

#### **1.2 DEFINITIONS**

- A.** CWP: Cold working pressure.
- B.** EPDM: Ethylene propylene-diene terpolymer rubber.
- C.** NBR: ABS, Buna-N, or nitrile butadiene rubber.

#### **1.3 ACTION SUBMITTALS**

- A.** Product Data: For each type of valve.

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A.** Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
  2. Protect threads, flange faces, grooves, and weld ends.
  3. Set butterfly valves closed or slightly open.
- B.** Use the following precautions during storage:
1. Maintain valve end protection.
  2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C.** Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.



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PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Standards:

1. Domestic water piping specialties intended to convey or dispense water for human consumption must comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or must be certified to be in compliance with NSF 61 and NSF 372 (by an ANSI-accredited third-party certification body) that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

- B. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B16.5 for flanges on steel valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.9 for building services valves.

- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

- E. Valve Sizes: Same as upstream piping unless otherwise indicated.

- F. Valve Actuator Types:

1. Hand lever: For valves NPS 6 (DN 150) and smaller.

- G. Valves in Insulated Piping: Provide 2-inch (50-mm) extended neck stems.

2.3 IRON, SINGLE-FLANGE (LUG-TYPE) BUTTERFLY VALVES

- A. Iron, Single-Flange (Lug-Type) Butterfly Valves with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:



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- a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. DeZURIK.
  - c. Flo Fab Inc.
  - d. Hammond Valve.
  - e. Kennedy Valve Company; a division of McWane, Inc.
  - f. KITZ Corporation.
  - g. Milwaukee Valve Company.
  - h. NIBCO INC.
  - i. Norriseal.
  - j. Viega LLC.
- 3. Standard: MSS SP-67, Type I.
  - 4. CWP Rating, NPS 12 (DN 300) and Smaller: 200 psig (1380 kPa).
  - 5. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
  - 6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
  - 7. Seat: EPDM.
  - 8. Stem: One- or two-piece stainless steel.
  - 9. Disc: Stainless steel.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- D. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

### 3.2 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.
- B. Provide support to piping adjacent to valves such that no force is imposed upon valves.
- C. Locate valves for easy access.



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- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full valve actuation movement.
- F. Valve Tags: Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. If leakage cannot be repaired, replace valves.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2-1/2 (DN 65) and Larger:
  - 1. Iron, Single-Flange (Lug-Type) Butterfly Valves: 200 CWP, EPDM seat, and stainless steel disc.

**END OF SECTION 22 05 23.13**



## **SECTION 22 05 23.14 - CHECK VALVES FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Bronze, swing check valves.
  - 2. Bronze, swing check valves, press ends.

#### **1.2 DEFINITIONS**

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer.
- C. NBR: Nitrile butadiene rubber (also known as Buna-N).

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of valve.

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, press connections, and weld ends.
  - 3. Set check valves in either closed or open position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's instructions.



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PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Standards:

1. Domestic water piping check valves intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372, or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

- B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges for metric standard piping.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast-copper solder joint.
6. ASME B16.22 for wrought copper solder joint.
7. ASME B16.51 for press joint.
8. ASME B31.9 for building services piping valves.

- C. AWWA Compliance: Comply with AWWA C606 for groove-end connections.

- D. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

- F. Valve Sizes: Same as upstream piping unless otherwise indicated.

- G. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE, LIFT CHECK VALVES

- A. Bronze, Lift Check Valves with Bronze Disc, Class 125:



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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. A.Y. McDonald Mfg. Co.
  - b. American Valve, Inc.
  - c. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - d. Crane Valves; a Crane Co. brand.
  - e. Flomatic Valves.
  - f. Jenkins Valves; a Crane Co. brand.
  - g. Jomar Valve.
  - h. Keckley Company.
  - i. Metraflex Company (The).
  - j. Milwaukee Valve Company.
  - k. NIBCO INC.
  - l. Stockham; a Crane Co. brand.
  - m. Val-Matic Valve & Manufacturing Corp.
  - n. Victaulic Company.
  - o. WATTS.
3. Description:
  - a. Standard: MSS SP-80, Type 1.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Vertical flow.
  - d. Body Material: ASTM B61 or ASTM B62, bronze.
  - e. Ends: Threaded or soldered. See valve schedule articles.
  - f. Disc: Bronze.

B. Bronze, Lift Check Valves with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Crane Valves; a Crane Co. brand.
  - b. Jenkins Valves; a Crane Co. brand.
  - c. Jomar Valve.
  - d. Keckley Company.
  - e. Lance Valves.
  - f. Milwaukee Valve Company.
  - g. NIBCO INC.
  - h. Red-White Valve Corp.
  - i. Shurjoint-Apollo Piping Products USA Inc.
  - j. Stockham; a Crane Co. brand.
  - k. Val-Matic Valve & Manufacturing Corp.
  - l. Victaulic Company.
3. Description:



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- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Vertical flow.
- d. Body Material: ASTM B61 or ASTM B62, bronze.
- e. Ends: Threaded or soldered. See valve schedule articles.
- f. Disc: NBR, PTFE.

## 2.4 BRONZE SWING CHECK VALVES

### A. Bronze, Swing Check Valves with Bronze Disc, Class 125:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. Jenkins Valves; a Crane Co. brand.
  - c. Milwaukee Valve Company.
  - d. NIBCO INC.
  - e. Stockham; a Crane Co. brand.
- 3. Description:
  - a. Standard: MSS SP-80, Type 3.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Horizontal flow.
  - d. Body Material: ASTM B62, bronze.
  - e. Ends: Threaded or soldered. See valve schedule articles.
  - f. Disc: Bronze.

### B. Bronze, Swing Check Valves, Press Ends:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. Elkhart Products Corporation.
  - c. Hammond Valve.
  - d. Milwaukee Valve Company.
  - e. NIBCO INC.
- 2. Description:
  - a. Standard: MSS SP-80 and MSS SP-139.
  - b. CWP Rating: Minimum 200 psig (1380 kPa).
  - c. Body Design: Horizontal flow.
  - d. Body Material: ASTM B584, bronze.
  - e. Ends: Press.
  - f. Press Ends Connection Rating: Minimum 200 psig (1380 kPa).



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- g. Disc: Brass or bronze.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Examine press fittings to verify they have been properly press.
- F. Do not attempt to repair defective valves; replace with new valves.

### 3.2 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Provide support of piping adjacent to valves such that no force is imposed upon valves.
- C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.
- D. Install valves so that stems are horizontal or slope upward from centerline of pipe.
- E. Install valves in position that does not project into aisles or block access to other equipment.
- F. Install valves in position to allow full stem and manual operator movement.
- G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.
- H. Check Valves: Install check valves for proper direction of flow.
  - 1. Swing Check Valves: In horizontal position with hinge pin level.



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- I. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
- J. Adhere to manufacturer's installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. End Connections:
  - 1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded, soldered, or press-end connections.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 (DN 50) and Smaller:
  - 1. Bronze, swing check valves with bronze disc, Class 125, with soldered or threaded end connections.
  - 2. Bronze, swing check valves with press-end connections.

**END OF SECTION 22 05 23.14**



## **SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:

- 1. Metal pipe hangers and supports.
- 2. Metal framing systems.
- 3. Thermal hanger-shield inserts.
- 4. Fastener systems.
- 5. Pipe stands.
- 6. Pipe-positioning systems.
- 7. Equipment supports.

- B. Related Requirements:

- 1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
- 2. Section 22 05 16 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
- 3. **Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment"** for vibration isolation devices.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

- 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

- 1. Trapeze pipe hangers.
- 2. Metal framing systems.



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- 3. Pipe stands.
- 4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

- 1. Detail fabrication and assembly of trapeze hangers.
- 2. Include design calculations for designing trapeze hangers.

#### 1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

#### 1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

#### 2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:



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1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

## 2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. B-line; Eaton, Electrical Sector.
  - c. Flex-Strut Inc.
  - d. Gregory Industries.
  - e. G-Strut.
  - f. Haydon Corporation.
  - g. Unistrut; Atkore International.
  - h. Wesanco, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with intumed lips.
5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Metallic Coating: Gold (yellow zinc dichromate) galvanized.



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B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Anvil International.
  - b. CADDY; nVent.
  - c. Carpenter & Paterson, Inc.
  - d. Eberl Iron Works, Inc.
  - e. Empire Industries, Inc.
  - f. FNW; Ferguson Enterprises, Inc.
  - g. Gripple Inc.
  - h. HoldRite; Reliance Worldwide Company.
  - i. MIRO Industries.
  - j. PHD Manufacturing, Inc.
  - k. Sioux Chief Manufacturing Company, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with inturned lips.
5. Channel Width: Select for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Metallic Coating: Pregalvanized G90 (Z275)

2.4 THERMAL HANGER-SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Buckaroos, Inc.
  2. CADDY; nVent.
  3. Carpenter & Paterson, Inc.
  4. National Pipe Hanger Corporation.
  5. Pipe Shields Inc.
  6. Piping Technology & Products, Inc.
  7. Rilco Manufacturing Co., Inc.
  8. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig (688-kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psig (688-kPa) ASTM C552, Type II cellular glass with 100-



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psig (688-kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

## 2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Hilti, Inc.
  - 2. ITW Ramset/Red Head; Illinois Tool Works, Inc.
  - 3. MKT Fastening, LLC.
  - 4. Simpson Strong-Tie Co., Inc.
- C. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. B-line; Eaton, Electrical Sector.
    - b. Empire Tool and Manufacturing Co., Inc.
    - c. Hilti, Inc.
    - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
    - e. MKT Fastening, LLC.
  - 2. Indoor Applications: Zinc-coated or stainless steel.
  - 3. Outdoor Applications: Stainless steel.

## 2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand:



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1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Hardware: Galvanized steel or polycarbonate.
4. Accessories: Protection pads.

C. Low-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Vertical Members: Two stainless-steel, continuous-thread, 1/2-inch (12-mm) rods.
4. Horizontal Member: Adjustable horizontal, stainless-steel pipe support channels.
5. Pipe Supports: Clevis hanger.
6. Hardware: Stainless steel.
7. Accessories: Protection pads.
8. Height: **12 inches (300 mm) above roof**

2.7 PIPE-POSITIONING SYSTEMS

- A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.9 MATERIALS

- A. Aluminum: ASTM B221 (ASTM B221M).
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
  2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.



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PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:



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1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
- G. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- O. Insulated Piping:
  1. Attach clamps and spacers to piping.
    - a. Piping Operating Below and Above Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    - b. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
  2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
  3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.



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4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
  - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
  - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
  - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

### 3.3 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

### 3.4 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 09 91 13 "Exterior Painting."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

### 3.5 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.



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- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal hanger-shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C) pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
  - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
  - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
  - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
  - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
  - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
  - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
  - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).



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12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
  13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
  17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction occurs.
  18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction occurs.
  19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
  20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
  21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches (150 mm) for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.



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5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb (340 kg).
    - b. Medium (MSS Type 32): 1500 lb (680 kg).
    - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:



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1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
  6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
  7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

**END OF SECTION 22 05 29**



**SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Elastomeric hangers.
  - 2. Snubbers.
  - 3. Restraints - rigid type.
  - 4. Restraints - cable type.
  - 5. Restraint accessories.
  - 6. Post-installed concrete anchors.
- B. Related Requirements:
  - 1. Section 23 05 48 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

**1.3 DEFINITIONS**

- A. Designated Seismic System: A plumbing component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.
- B. IBC: International Building Code.
- C. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.



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1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-force-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic- restraint component.
4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by ICC-ES product listing an evaluation service member of ICC-ES OSHPD or an agency acceptable to authorities having jurisdiction.
5. Annotate to indicate application of each product submitted and compliance with requirements.
6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. For each seismic-restraint device, including seismic-restrained mounting, seismic restraint, seismic-restraint accessory, and concrete anchor and insert, that is required by this Section or is indicated on Drawings, submit the following:
  - a. Seismic restraint, and vibration isolator, and isolation base selection: Select vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
  - b. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
  - c. Seismic Design Calculations: Submit all input data and loading calculations prepared in "Performance Requirements" Article in "Seismic Design Calculations" Paragraph.
  - d. Qualified Professional Engineer: All designated-design submittals for seismic calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
2. Seismic- Restraint Detail Drawing:
  - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
  - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths,



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and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

- c. Coordinate seismic restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
- 3. Product Listing, Preapproval, and Evaluation Documentation: By an evaluation service member of ICC-ES OSHPD or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- 4. All delegated-design submittals for seismic- restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. professional engineerWelding certificates.
- C. Field quality-control reports:
- D. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.
  - 1. Provide equipment manufacturer's written certification for each designated active plumbing seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270 (AHRI 1271), including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction, or experience data as permitted by ASCE/SEI 7-16.
  - 2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-16.
  - 3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.



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1.6 CLOSEOUT SUBMITTALS

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic- Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing an evaluation service member of ICC-ES [an agency acceptable to authorities having jurisdiction].

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. DelegatedDesign: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design seismic control system.
  - 1. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7-16.
- B. Seismic Design Calculations:
  - 1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05 ASCE/SEI 7-10 including supplement No. 1 ASCE/SEI 7-16. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the section text.
    - a. Data indicated below to be determined by Delegated-Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
    - b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
    - c. Building Occupancy Category: IV.



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- d. Building Risk Category: III.
  - e. Building Site Classification: E.
2. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.
- a. Horizontal Seismic Design Force  $F_p$ : Value is to be calculated by Delegated-Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation.
    - 1)  $S_{DS}$  = Spectral Acceleration: 0.612g. Value applies to all components on Project.
    - 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.
    - 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
    - 4)  $W_p$  = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from each component submittal.
  - b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
  - c. Seismic Relative Displacement  $D_{pi}$ : Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:
    - 1)  $D_p$  = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated-Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
    - 2)  $I_e$  = Structure Importance Factor: II. Value applies to all components on Project.
    - 3)  $\delta_{xA}$  = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
    - 4)  $\delta_{yA}$  = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
    - 5)  $\delta_{yB}$  = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
    - 6)  $h_x$  = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
    - 7)  $h_y$  = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
    - 8)  $\Delta_{aA}$  = Allowable Story Drift for Structure A: See Drawing Schedules for each component.
    - 9)  $\Delta_{aB}$  = Allowable Story Drift for Structure B: See Drawing Schedules for each component.



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- 10)  $h_{sx}$  = Story Height Used in the Definition of Allowable Drift  $\Delta_a$ : See Drawings Schedules for each component.
- d. Component Fundamental Period  $T_p$ : Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:
  - 1)  $W_p$  = Component Operating Weight: Determined by Contractor from Project Drawings and manufacturer's data.
  - 2)  $g$  = Gravitational Acceleration: 32.17 fps<sup>2</sup> (9.81 m/s<sup>2</sup>).
  - 3)  $K_p$  = Combined Stiffness of the Component, Supports, and Attachments: Determined by delegated-design seismic engineer..
- C. Consequential Damage: Provide additional seismic restraints for suspended plumbing components or anchorage of floor, roof or wall mounted plumbing components as indicated in ASCE/SEI 7-05 ASCE/SEI 7-10 ASCE/SEI 7-16 so that failure of a non-essential or essential plumbing component will not cause the failure of any other essential architectural, mechanical or electrical building component.
- D. Fire/Smoke Resistance: Seismic- restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- E. Component Supports:
  - 1. Load Ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
  - 2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-05 Section 13.6 ASCE/SEI 7-10 Section 13.6 ASCE/SEI 7-16 Section 13.6.

## 2.2 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:..
  - 1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
    - a. [Acoustic Systems.](#)
    - b. [Advanced Antivibration Components /A VMC Group Company.](#)
    - c. [Amber/Booth Co.](#)
    - d. [Flextegrity, Inc.](#)
    - e. [Flex-Weld / Keflex Mfg.](#)
    - f. [General Rubber Corp.](#)
    - g. [Kinetics Noise Control Inc.](#)



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- h. [MAPA Products.](#)
  - i. [Mason Industries, Inc.](#)
  - j. [MIFAB, Inc.](#)
  - k. [MIRO Industries Inc.](#)
  - l. [Novia - A Division of Carpenter & Paterson.](#)
  - m. [PAC International, Inc.](#)
  - n. [PHP Systems Design.](#)
  - o.
  - p. [Seismic Control Products, LLC.](#)
- 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
  - 3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

## 2.3 RESTRAINTS - RIGID TYPE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - 1. [Acoustic Systems.](#)
  - 2. [Advanced Antivibration Components /A VMC Group Company.](#)
  - 3. [Amber/Booth Co.](#)
  - 4. [Flextegrity, Inc.](#)
  - 5. [Flex-Weld / Keflex Mfg.](#)
  - 6. [General Rubber Corp.](#)
  - 7. [Kinetics Noise Control Inc.](#)
  - 8. [MAPA Products.](#)
  - 9. [Mason Industries, Inc.](#)
  - 10. [MIFAB, Inc.](#)
  - 11. [MIRO Industries Inc.](#)
  - 12. [Novia - A Division of Carpenter & Paterson.](#)
  - 13. [PAC International, Inc.](#)
  - 14. [PHP Systems Design.](#)
  - 15. [Plumberex Specialty Products, Inc.](#)
  - 16. [Seismic Control Products, LLC.](#)
- B. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.



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2.4 RESTRAINTS - CABLE TYPE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
1. [Acoustic Systems.](#)
  2. [Advanced Antivibration Components /A VMC Group Company.](#)
  3. [Amber/Booth Co.](#)
  4. [Flextegrity, Inc.](#)
  5. [Flex-Weld / Keflex Mfg.](#)
  6. [General Rubber Corp.](#)
  7. [Kinetics Noise Control Inc.](#)
  8. [MAPA Products.](#)
  9. [Mason Industries, Inc.](#)
  10. [MIFAB, Inc.](#)
  11. [MIRO Industries Inc.](#)
  12. [Novia - A Division of Carpenter & Paterson.](#)
  13. [PAC International, Inc.](#)
  14. [PHP Systems Design.](#)
  15. [Plumberex Specialty Products, Inc.](#)
  16. [Seismic Control Products, LLC.](#)
- B. Seismic- Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.
- C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge type end fittings do not comply and are unacceptable.

2.5 RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
1. [Acoustic Systems.](#)
  2. [Advanced Antivibration Components /A VMC Group Company.](#)
  3. [Amber/Booth Co.](#)
  4. [Flextegrity, Inc.](#)
  5. [Flex-Weld / Keflex Mfg.](#)
  6. [General Rubber Corp.](#)
  7. [Kinetics Noise Control Inc.](#)
  8. [MAPA Products.](#)
  9. [Mason Industries, Inc.](#)



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10. [MIFAB, Inc.](#)
11. [MIRO Industries Inc.](#)
12. [Novia - A Division of Carpenter & Paterson.](#)
13. [PAC International, Inc.](#)
14. [PHP Systems Design.](#)
15. [Plumberex Specialty Products, Inc.](#)
16. [Seismic Control Products, LLC.](#)

- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections, or Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

## 2.6 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Acoustic Systems.](#)
  - b. [Advanced Antivibration Components /A VMC Group Company.](#)
  - c. [Amber/Booth Co.](#)
  - d. [Flextegrity, Inc.](#)
  - e. [Flex-Weld / Keflex Mfg.](#)
  - f. [General Rubber Corp.](#)
  - g. [Kinetics Noise Control Inc.](#)
  - h. [MAPA Products.](#)
  - i. [Mason Industries, Inc.](#)
  - j. [MIFAB, Inc.](#)
  - k. [MIRO Industries Inc.](#)
  - l. [Novia - A Division of Carpenter & Paterson.](#)
  - m. [PAC International, Inc.](#)
  - n. [PHP Systems Design.](#)
  - o. [Plumberex Specialty Products, Inc.](#)



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- p. [Seismic Control Products, LLC.](#)
- 2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- B. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-16, Ch. 13.
  - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
  - 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.
- C. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW), which is not vibration isolated.
  - 1. Undercut expansion anchors are permitted.

## 2.7 CONCRETE INSERTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - 1. [Acoustic Systems.](#)
  - 2. [Advanced Antivibration Components /A VMC Group Company.](#)
  - 3. [Amber/Booth Co.](#)
  - 4. [Flextegrity, Inc.](#)
  - 5. [Flex-Weld / Keflex Mfg.](#)
  - 6. [General Rubber Corp.](#)
  - 7. [Kinetics Noise Control Inc.](#)
  - 8. [MAPA Products.](#)
  - 9. [Mason Industries, Inc.](#)
  - 10. [MIFAB, Inc.](#)
  - 11. [MIRO Industries Inc.](#)
  - 12. [Novia - A Division of Carpenter & Paterson.](#)
  - 13. [PAC International, Inc.](#)
  - 14. [PHP Systems Design.](#)
  - 15. [Plumberex Specialty Products, Inc.](#)
  - 16. [Seismic Control Products, LLC.](#)
- B. Provide preset concrete inserts, which are seismically prequalified in accordance with ICC-ES AC466 testing.
- C. Comply with ANSI/MSS 58.



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PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES OSHPD or an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and seismic load within specified loading limits.

3.3 INSTALLATION OF VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.
- B. Provide seismic-restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."
- D. Installation of vibration isolators and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.



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- E. Comply with requirements in Section 07 72 00 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- F. Equipment Restraints:
  - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
  - 2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES OSHPD or an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
  - 2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
  - 3. Brace a change of direction longer than 12 feet (3.7 m).
- H. Install seismic- restraint cables so they do not bend across edges of adjacent equipment or building structure.
- I. Install seismic- restraint devices using methods approved by an evaluation service member of ICC-ES OSHPD [an agency acceptable to authorities having jurisdiction] that provides required submittals for component.
- J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- M. Post-Installed Concrete Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify Project structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.



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4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 22 11 16 "Domestic Water Piping" and Section 22 11 19 "Domestic Water Piping Specialties" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
  1. Perform tests and inspections with the assistance of a factory-authorized service representative.
  2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  5. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  6. Test to 90 percent of rated proof load of device.
  7. Measure isolator restraint clearance.
  8. Measure isolator deflection.
  9. Verify snubber minimum clearances.
  10. Test and adjust restrained-air-spring isolator controls and safeties.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.



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**END OF SECTION 22 05 48**



## **SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data:** For each type of product indicated.
- B. Samples:** For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule:** Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve-numbering scheme.**
- E. Valve Schedules:** For each piping system. Include in operation and maintenance manuals.

### **PART 2 - PRODUCTS**

#### **2.1 EQUIPMENT LABELS**

**A. Plastic Labels for Equipment:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Brimar Industries, Inc.
  - c. Carlton Industries, LP.
  - d. Champion America.
  - e. Craftmark Pipe Markers.
  - f. emedco.
  - g. Kolbi Pipe Marker Co.
  - h. LEM Products Inc.



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- i. Marking Services, Inc.
  - j. Seton Identification Products; a Brady Corporation company.
- 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, with predrilled holes for attachment hardware.
  - 3. Letter and Background Color: As indicated for specific application under Part 3.
  - 4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
  - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
  - 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  - 7. Fasteners: Stainless steel rivets or self-tapping screws.
  - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

## 2.2 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  - 2. Brady Corporation.
  - 3. Brimar Industries, Inc.
  - 4. Carlton Industries, LP.
  - 5. Champion America.
  - 6. Craftmark Pipe Markers.
  - 7. emedco.
  - 8. Kolbi Pipe Marker Co.
  - 9. LEM Products Inc.
  - 10. Marking Services Inc.
  - 11. Seton Identification Products; a Brady Corporation company.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.



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- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
1. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
  2. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.3 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  2. Brady Corporation.
  3. Brimar Industries, Inc.
  4. Carlton Industries, LP.
  5. Champion America.
  6. Craftmark Pipe Markers.
  7. emedco.
  8. Kolbi Pipe Marker Co.
  9. LEM Products Inc.
  10. Marking Services Inc.
  11. Seton Identification Products; a Brady Corporation company.
- B. Description: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
1. Tag Material: Brass, 0.04-inch (1.0-mm) stainless steel, 0.024-inch (0.61-mm) aluminum, 0.031-inch (0.79-mm) or anodized aluminum, 0.031-inch (0.79-mm) minimum thickness, with predrilled or stamped holes for attachment hardware.
  2. Fasteners: Brass wire link chain beaded chain or S-hook.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Include valve-tag schedule in operation and maintenance data.



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PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of plumbing equipment.
- B. Sign and Label Colors.
  - 1. White letters on an ANSI Z535.1 safety-green background.
- C. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF PIPE LABELS

- A. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Within 3 ft. (1 m) of each valve and control device.
  - 2. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 3. Within 3 ft. (1 m) of equipment items and other points of origination and termination.
  - 4. Spaced at maximum intervals of 25 ft. (8 m) along each run. Reduce intervals to 10 ft. (3 m) in areas of congested piping and equipment.



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- B. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- C. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe-Label Color Schedule:
  - 1. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
  - 2. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background
  - 3. Domestic Hot-Water Return Piping White letters on an ANSI Z535.1 safety-green background.
  - 4. Sanitary Waste and Storm Drainage Piping: White letters on a black background.

### 3.5 INSTALLATION OF VALVE TAGS

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
  - 1. Valve-Tag Size and Shape:
    - a. Domestic Cold Water: 1-1/2 inches (38 mm), round.
    - b. Domestic Hot Water: 1-1/2 inches (38 mm), round.
    - c. Domestic Hot-Water Return: 1-1/2 inches (38 mm), round.
  - 2. Valve-Tag Colors:
    - a. For each piping system, use the same lettering and background coloring system on valve tags as used in the piping system labels and background.

**END OF SECTION 22 05 53**



## **SECTION 22 05 93 - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. TAB of domestic water system.
  - 2. TAB of plumbing equipment:
    - a. Domestic hot-water in-line circulation pumps.
  - 3. Pipe-leakage test verification.
  - 4. Testing, adjusting, and balancing of existing plumbing systems and equipment.

#### **1.3 DEFINITIONS**

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.

#### **1.4 PREINSTALLATION MEETINGS**

- A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
  - 1. Minimum Agenda Items:
    - a. The Contract Documents examination report.



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- b. The TAB plan.
- c. Needs for coordination and cooperation of trades and subcontractors.
- d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

1.6 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by AABC:
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
  - 2. TAB Technician: Employee of the TAB specialist and certified by AABC.
- B. TAB Specialists Qualifications, Certified by NEBB or TABB:
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
  - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.



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- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.
- E. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."
- F. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.7 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine approved submittals for plumbing systems and equipment.
- D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.
- E. Examine equipment performance data, including pump curves.



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1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.
- F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.
- J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- K. Examine system pumps to ensure absence of entrained air in the suction piping.
- L. Examine operating safety interlocks and controls on plumbing equipment.
- M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
1. Equipment and systems to be tested.
  2. Strategies and step-by-step procedures for balancing the systems.
  3. Instrumentation to be used.
  4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
1. Domestic Water System:



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- a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
- b. Water heaters are installed and functioning.
- c. Piping is complete and all points of outlet are installed.
- d. Water treatment is complete.
- e. Systems are flushed, filled, and air purged.
- f. Strainers are clean.
- g. Control valves are functioning in accordance with the sequence of operation.
- h. Shutoff and balance valves are 100 percent open.
- i. hot-water circulating pumps are operational and proper rotation is verified.
- j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
- k. Variable-frequency controllers' startup is complete and safeties are verified.
- l. Suitable access to balancing devices and equipment is provided.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
- B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
  1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
  2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 22 07 19 "Plumbing Piping Insulation."
- C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

### 3.4 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

- A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:
  1. Domestic water in-line pumps.
  2. Domestic water heaters.



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3.5 PROCEDURES FOR DOMESTIC WATER SYSTEMS

- A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:
  - 1. Check expansion tank for proper setting.
  - 2. Check water heater for proper discharge temperature setting.
  - 3. Check remotest point of outlet for adequate pressure.
  - 4. Check flow-control valves for proper position.
  - 5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
  - 6. Check that air has been purged from the system.
- D. Measure and record upstream and downstream pressure of each piece of equipment.
- E. Measure and record upstream and downstream pressure of pressure-reducing valves.
- F. Check settings and operation of automatic temperature-control valves. Record final settings.
- G. Check settings and operation of each safety valve. Record settings.

3.6 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

- A. Balance system with manual or automatic balancing valves by setting at design flow.
  - 1. Measure flow in main and branch pipes.
  - 2. Adjust main and branch balance valves for design flow.
- B. Adjust pump to deliver total design flow.
  - 1. Measure pump TDH as follows:
    - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    - c. Convert pressure to head and correct for differences in gauge heights.
    - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.



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2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
3. Mark final settings and verify that all memory stops have been set.
4. Verify final system conditions as follows:
  - a. Re-measure and confirm that total flow is within design.
  - b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
  - c. Mark final settings.

### 3.7 PROCEDURES FOR WATER HEATERS

#### A. Electric Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. Record relief valve(s) pressure setting.
5. Capacity: Calculate in Btu/h (kW) of heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

### 3.8 TOLERANCES

#### A. Set plumbing system's flow rates within the following tolerances:

1. Domestic Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm (0.63 L/s), within 10 percent.

### 3.9 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.



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3.10 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  2. Include a list of instruments used for procedures, along with proof of calibration.
  3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
  2. Manufacturers' test data.
  3. Field test reports prepared by system and equipment installers.
  4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
  2. Name and address of the TAB specialist.
  3. Project name.
  4. Project location.
  5. Architect's name and address.
  6. Engineer's name and address.
  7. Contractor's name and address.
  8. Report date.
  9. Signature of TAB supervisor who certifies the report.
  10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  11. Summary of contents, including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  12. Nomenclature sheets for each item of equipment.
  13. Notes to explain why certain final data in the body of reports vary from indicated values.
  14. Test conditions for pump performance forms, including the following:
    - a. Variable-frequency controller settings for variable-flow hydronic systems.
    - b. Settings for pressure controller(s).
    - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:



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1. Flow rates.
  2. Pipe and valve sizes and locations.
  3. Balancing stations.
  4. Position of balancing devices.
- E. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
    - a. System identification.
    - b. Location.
    - c. Model number and unit size.
    - d. Manufacturer's serial number.
    - e. Output capacity in Btu/h (kW).
    - f. Number of stages.
    - g. Connected volts, phase, and hertz.
    - h. Rated amperage.
  2. Test Data (Indicated and Actual Values):
    - a. Heat output in Btu/h (kW).
    - b. Entering-water temperature in deg F (deg C).
    - c. Leaving-water temperature in deg F (deg C).
    - d. High-temperature-limit setting in deg F (deg C).
    - e. Operating set point in deg F (deg C).
    - f. Voltage at each connection.
    - g. Amperage for each phase.
- F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:
1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Service.
    - d. Make and size.
    - e. Model number and serial number.
    - f. Water flow rate in gpm (L/s).
    - g. Water-pressure differential in feet of head or psig (kPa).
    - h. Required net positive suction head in feet of head or psig (kPa).
    - i. Pump speed.
    - j. Impeller diameter in inches (mm).
    - k. Motor make and frame size.
    - l. Motor horsepower and rpm.
    - m. Voltage at each connection.
    - n. Amperage for each phase.
    - o. Full-load amperage and service factor.



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- p. Seal type.
  - 2. Test Data (Indicated and Actual Values):
    - a. Static head in feet of head or psig (kPa).
    - b. Pump shutoff pressure in feet of head or psig (kPa).
    - c. Actual impeller size in inches (mm).
    - d. Full-open flow rate in gpm (L/s).
    - e. Full-open pressure in feet of head or psig (kPa).
    - f. Final discharge pressure in feet of head or psig (kPa).
    - g. Final suction pressure in feet of head or psig (kPa).
    - h. Final total pressure in feet of head or psig (kPa).
    - i. Final water flow rate in gpm (L/s).
    - j. Voltage at each connection.
    - k. Amperage for each phase.
  - G. Instrument Calibration Reports:
    - 1. Report Data:
      - a. Instrument type and make.
      - b. Serial number.
      - c. Application.
      - d. Dates of use.
      - e. Dates of calibration.
- 3.11 VERIFICATION OF TAB REPORT
- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.
  - B. a normal 8-hour business day.
  - C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
  - D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.
  - E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
    - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.



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2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.12 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

**END OF SECTION 22 05 93**



## **SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Liquid-in-glass thermometers.
  - 2. Thermowells.
  - 3. Test plugs.
  - 4. Test-plug kits.
- B. Related Requirements:
  - 1. Section 22 11 19 "Domestic Water Piping Specialties" for water meters.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Product Certificates: For each type of meter and gage.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

### **PART 2 - PRODUCTS**

#### **2.1 LIQUID-IN-GLASS THERMOMETERS**

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:



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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Flo Fab Inc.
  - b. Miljoco Corporation.
  - c. Palmer Wahl Instrumentation Group.
  - d. Tel-Tru Manufacturing Company.
  - e. Terice, H. O. Co.
  - f. Weiss Instruments, Inc.
  - g. Weksler Glass Thermometer Corp.
  - h. Winters Instruments - U.S.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 7-inch (178-mm) nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
7. Window: Glass or plastic.
8. Stem: Aluminum and of length to suit installation.
  - a. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.2 THERMOWELLS

### A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. External Threads: NPS 1/2, NPS 3/4, or NPS 1 (DN 15, DN 20, or NPS 25), ASME B1.20.1 pipe threads.
6. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
7. Bore: Diameter required to match thermometer bulb or stem.
8. Insertion Length: Length required to match thermometer bulb or stem.
9. Lagging Extension: Include on thermowells for insulated piping and tubing.
10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

### B. Heat-Transfer Medium:.



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2.3 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. IMI Flow Design, Inc.
  2. Miljoco Corporation.
  3. Nexus Valve, Inc.
  4. Peterson Equipment Co., Inc.
  5. Sisco Manufacturing Company, Inc.
  6. Trerice, H. O. Co.
  7. WATTS.
  8. Weiss Instruments, Inc.
  9. Weksler Glass Thermometer Corp.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
- F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.4 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. IMI Flow Design, Inc.
  2. Miljoco Corporation.
  3. Nexus Valve, Inc.
  4. Peterson Equipment Co., Inc.
  5. Sisco Manufacturing Company, Inc.
  6. Trerice, H. O. Co.
  7. WATTS.
  8. Weiss Instruments, Inc.
- B. Furnish one test-plug kit(s) containing one thermometer(s), and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C).



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- D. Carrying Case: Metal or plastic, with formed instrument padding.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install test plugs in piping tees.
- G. Install thermometers in the following locations:
  - 1. Inlet and outlet of each water heater.

### 3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

### 3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

### 3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be **one of** the following:
  - 1. Direct -mounted, metal -case, vapor-actuated type.
  - 2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.
- B. Thermometer stems shall be of length to match thermowell insertion length.



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3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F (0 to 150 deg C).

**END OF SECTION 22 05 19**



## **SECTION 22 07 19 - PLUMBING PIPING INSULATION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes insulating the following plumbing piping services:
  - 1. Domestic hot-water piping.
  - 2. Domestic recirculating hot-water piping.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Sustainable Design Submittals:
  - 1. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 3. Detail removable insulation at piping specialties, equipment connections, and access panels.
  - 4. Detail application of field-applied jackets.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of



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insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

- C. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
  - 1. Piping Mockups:
    - a. Four support hangers, including hanger shield and insert.
  - 2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
  - 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
  - 4. Obtain Architect's approval of mockups before starting insulation application.
  - 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  - 7. Demolish and remove mockups when directed.
- D. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.



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1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.



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- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA.
    - b. Armacell LLC.
    - c. K-Flex USA.
- G. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. Knauf Insulation.
    - c. Manson Insulation Inc.
    - d. Owens Corning.
  - 2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ-SSL.
  - 3. 850 deg F (454 deg C).
  - 4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
  - 5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Ramco Insulation, Inc.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Ramco Insulation, Inc.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Ramco Insulation, Inc.



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2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA.
    - b. Armacell LLC.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. K-Flex USA.
  - 2. Adhesive: As recommended by flexible elastomeric and polyolefin manufacturer and with a VOC content of 80 g/L or less.
  - 3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. M, and acetaldehyde concentration does not exceed 9 mcg/cu. m.
  - 4. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
  - 5. Wet Flash Point: Below 0 deg F (minus 18 deg C).
  - 6. Service Temperature Range: 40 to 200 deg F (4 to plus 93 deg C).
  - 7. Color: Black.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Mon-Eco Industries, Inc.
  - 2. Adhesive: As recommended by mineral fiber manufacturer and with a VOC content of 80 g/L or less.
  - 3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. M, and acetaldehyde concentration does not exceed 9 mcg/cu. m.
- D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.



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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Foster Brand; H. B. Fuller Construction Products.
  - c. Mon-Eco Industries, Inc.
2. Verify adhesives have a VOC content of 80 g/L or less.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Johns Manville; a Berkshire Hathaway company.
  - b. P.I.C. Plastics, Inc.
  - c. Speedline Corporation.
2. Adhesive: As recommended by Adhesive - PVC Jacket manufacturer and with a VOC content of [50] g/L or less.

## 2.4 LAGGING ADHESIVES

A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Foster Brand; H. B. Fuller Construction Products.
  - c. Vimasco Corporation.
2. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of 50 g/L or less.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 20 to plus 180 deg F (Minus 6 to plus 82 deg C).
5. Color: White.

## 2.5 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.



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- b. Foster Brand; H. B. Fuller Construction Products.
    - c. Mon-Eco Industries, Inc.
  - 2. Permanently flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 58 to plus 176 deg F (Minus 50 to plus 80 deg C).
  - 4. Color: White or gray.
  - 5. Verify sealant has a VOC content of 420 g/L or less.
- C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
  - 2. Fire- and water-resistant, flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
  - 4. Color: White.
  - 5. Verify sealant has a VOC content of 420 g/L or less.

## 2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
- 1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

## 2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.
- B. PVC Fitting Covers: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. P.I.C. Plastics, Inc.
    - c. Proto Corporation.
    - d. Speedline Corporation.
  - 2. Adhesive: As recommended by jacket material manufacturer.
  - 3. Color: White.



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4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
  - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

## 2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. 3M Industrial Adhesives and Tapes Division.
    - b. Avery Dennison Corporation, Specialty Tapes Division.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
    - d. Knauf Insulation.
  2. Width: 3 inches (75 mm).
  3. Thickness: 11.5 mils (0.29 mm).
  4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. 3M Industrial Adhesives and Tapes Division.
    - b. Ideal Tape Co., Inc., an American Biltrite Company.
  2. Width: 2 inches (50 mm).
  3. Thickness: 6 mils (0.15 mm).
  4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

## 2.9 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers,:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Buckaroos, Inc.
    - b. Just Manufacturing.



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- c. McGuire Manufacturing.
  - d. MVG Molded Products.
  - e. Plumberex Specialty Products, Inc.
  - f. Truebro.
  - g. Zurn Industries, LLC.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

#### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.



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- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
  - 3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches (100 mm) o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.



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- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- P. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Cleanouts.

### 3.4 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- C. Insulation Installation at Floor Penetrations:
  - 1. Pipe: Install insulation continuously through floor penetrations.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

### 3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
  - 1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill



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- joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
  7. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.



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3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  1. Install pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
  4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
  1. Install mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
  1. Install preformed valve covers manufactured of same material as that of pipe insulation when available.
  2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  3. Install insulation to flanges as specified for flange insulation application.
  4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.



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3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.



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1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

### 3.9 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
  1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless steel jackets.

### 3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.



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B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.12 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Hot and Recirculated Hot Water:

1. NPS 3/4 and Smaller: Insulation shall be one of the following:
  - a. Flexible Elastomeric: 1 inch (25 mm) thick.
  - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
2. NPS 1 to NPS 1-1/2: Insulation shall be one of the following:
  - a. Flexible Elastomeric: 1-1/2 inches thick.
  - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) 1-1/2 inches thick.

### 3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install fitting covers over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
1. PVC: 20 mils (0.5 mm) thick.
- D. Piping, Exposed:
1. PVC: 20 mils (0.5 mm) thick.

**END OF SECTION 22 07 19**



## **SECTION 22 11 16 - DOMESTIC WATER PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Copper tube and fittings.
  - 2. Piping joining materials.
  - 3. Encasement for piping.
  - 4. Transition fittings.
  - 5. Dielectric fittings.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data:
  - 1. Pipe and tube.
  - 2. Fittings.
  - 3. Joining materials.
  - 4. Transition fittings.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. System purging and disinfecting activities report.
- C. Field quality-control reports.

#### **1.5 FIELD CONDITIONS**

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then



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only after arranging to provide temporary water service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

- A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.

### 2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type L (ASTM B88M, Type B).
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- F. Wrought Copper Unions: ASME B16.22.
- G. Copper Tube, Pressure-Seal-Joint Fittings:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    - b. Conex Banninger - USA.
    - c. Elkhart Products Corporation.
    - d. Mueller Industries, Inc.
    - e. NIBCO INC.
    - f. Viega LLC.
  2. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
  3. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).



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2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
  - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
  - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B32, lead-free alloys.
- D. Flux: ASTM B813, water flushable.
- E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 ENCASEMENT FOR PIPING

- A. Standard: ASTM A674 or AWWA C105/A21.5.
- B. Form: Sheet or tube.
- C. Color: Black or natural.

2.5 TRANSITION FITTINGS

- A. General Requirements:
  - 1. Same size as pipes to be joined.
  - 2. Pressure rating at least equal to pipes to be joined.
  - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cascade Waterworks Mfg. Co.
    - b. Dresser, Inc.
    - c. Ford Meter Box Company, Inc. (The).
    - d. Jay R. Smith Mfg Co; a division of Morris Group International.
    - e. JCM Industries, Inc.
    - f. Romac Industries, Inc.



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- g. Smith-Blair, Inc.
- h. Viking Johnson.

## 2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. A.Y. McDonald Mfg. Co.
    - b. Capitol Manufacturing Company.
    - c. Central Plastics Company.
    - d. HART Industrial Unions, LLC.
    - e. Jomar Valve.
    - f. WATTS.
    - g. Wilkins.
    - h. Zurn Industries, LLC.
  - 2. Standard: ASSE 1079.
  - 3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
  - 4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Capitol Manufacturing Company.
    - b. Central Plastics Company.
    - c. Matco-Norca.
    - d. WATTS.
    - e. Wilkins.
    - f. Zurn Industries, LLC.
  - 2. Standard: ASSE 1079.
  - 3. Factory-fabricated, bolted, companion-flange assembly.
  - 4. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
  - 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Advance Products & Systems, Inc.



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- b. Calpico, Inc.
    - c. Central Plastics Company.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Nonconducting materials for field assembly of companion flanges.
  - 3. Pressure Rating: 150 psig (1035 kPa).
  - 4. Gasket: Neoprene or phenolic.
  - 5. Bolt Sleeves: Phenolic or polyethylene.
  - 6. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Elster Perfection Corporation.
    - b. Grinnell G-Fire by Johnson Controls Company.
    - c. Matco-Norca.
    - d. Precision Plumbing Products.
    - e. Sioux Chief Manufacturing Company, Inc.
    - f. Victaulic Company.
  - 2. Standard: IAPMO PS 66.
  - 3. Electroplated steel nipple complying with ASTM F1545.
  - 4. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).
  - 5. End Connections: Male threaded or grooved.
  - 6. Lining: Inert and noncorrosive, propylene.

### PART 3 - EXECUTION

#### 3.1 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Underground, domestic water, building-service piping, NPS 3 (DN 80) and smaller, shall be the following:
  - 1. Annealed-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); wrought-copper, solder-joint fittings; and brazed or copper pressure-seal fittings; and pressure-sealed joints.



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- E. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
  - 1. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); wrought-copper, solder-joint fittings; and brazed or copper pressure-seal-joint fittings; and pressure-sealed joints.
- F. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
  - 1. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast- or wrought-copper, solder-joint fittings; and soldered joints.
  - 2. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
- G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be the following:
  - 1. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast- or wrought-copper, solder-joint fittings; and soldered joints.
  - 2. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.

### 3.2 EARTHWORK

- A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

### 3.3 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install underground copper tube in PE encasement according to ASTM A674 or AWWA C105/A21.5.
- D. Install valves according to the following:
  - 1. Section 22 05 23.12 "Ball Valves for Plumbing Piping."
  - 2. Section 22 05 23.13 "Butterfly Valves for Plumbing Piping."
  - 3. Section 22 05 23.14 "Check Valves for Plumbing Piping."
- E. Install domestic water piping level without pitch and plumb.



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- F. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- G. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping to permit valve servicing.
- L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and branch connections.
- O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- P. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 11 23 "Domestic Water Pumps."
- Q. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."



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3.4 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.5 INSTALLATION OF TRANSITION FITTINGS

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
  - 2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

3.6 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples or unions.



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- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges or flange kits.

### 3.7 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for hangers, supports, and anchor devices in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- C. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
  - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
  - 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection.

### 3.9 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."



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3.10 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
  2. Open shutoff valves to fully open position.
  3. Open throttling valves to proper setting.
  4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
  5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
  6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
  7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
  8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Piping Inspections:
    - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
    - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
    - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
  2. Piping Tests:
    - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
    - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
    - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.



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- d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
  - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
  - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.12 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
    - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - b. Fill and isolate system according to either of the following:
      - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
      - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
    - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    - d. Repeat procedures if biological examination shows contamination.
    - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

**END OF SECTION 22 11 16**



## **SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Temperature-actuated, water mixing valves.
5. Strainers for domestic water piping.
6. Outlet boxes.
7. Hose bibbs.
8. Drain valves.
9. Water-hammer arresters.
10. Trap-seal primer systems.
11. Flexible connectors.

- B. Related Requirements:

1. Section 21 11 00 "Facility Fire-Suppression Water-Service Piping" for fire water-service backflow prevention devices.
2. Section 22 05 19 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gauges, and flow meters in domestic water piping.
3. Section 22 11 16 "Domestic Water Piping" for water meters.
4. Section 22 32 00 "Domestic Water Filtration Equipment" for water filters in domestic water piping.
5. Section 22 43 00 "Healthcare Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
6. Section 22 45 00 "Emergency Plumbing Fixtures" for water tempering equipment.
7. Section 22 47 16 "Pressure Water Coolers" for water filters for water coolers.
8. Section 22 47 23 "Remote Water Coolers" for water filters for water coolers.
9. Section 23 09 23.18 "Leak Detection Instruments" for leak detection devices related to HVAC applications.



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1.3 DEFINITIONS

- A. AMI: Advanced Metering Infrastructure.
- B. AMR: Automatic Meter Reading.
- C. FKM: A family of fluoroelastomer materials defined by ASTM D1418.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
  - 1. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Test and inspection reports.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.



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2.3 VACUUM BREAKERS

A. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. Cash Acme, A Division of Reliance Worldwide Corporation.
  - c. Champion - Arrowhead.
  - d. Legend Valve & Fitting, Inc.
  - e. MIFAB, Inc.
  - f. WATTS.
  - g. Woodford Manufacturing Company.
  - h. Zurn Industries, LLC.
2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

A. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers BFP-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts product indicated on Drawings or comparable product by one of the following:
2. Standard: ASSE 1032.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10).
5. Body: Stainless steel.
6. End Connections: Threaded or flare.

2.5 BALANCING VALVES

A. Automatic Flow Control Balancing Valves BV-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Griswold product indicated on Drawings or comparable product by one of the following:
  - a. Caleffi.
  - b. Hays Fluid Controls, a Div. of ROMAC Industries
2. Flow Regulation: Plus or minus 5 percent over 95 percent of the working range.
3. Pressure Rating: 200 psig (1380 kPa).
4. Size: NPS 2 (DN 50) or smaller.
5. Body: Stainless steel or brass.
6. Flow Cartridge: Stainless steel or antiscaling polymer.



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7. End Connections: Threaded or solder joint.

## 2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

### A. Water-Temperature Limiting Devices TMV-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Cash AME product indicated on Drawings or comparable product by one of the following:
  - a. Acorn Engineering Company; a Division of Morris Group International.
  - b. Leonard Valve Company.
  - c. POWERS; A WATTS Brand.
  - d. Symmons Industries, Inc.
  - e. Taco Comfort Solutions, Inc.
  - f. WATTS.
  - g. Zurn Industries, LLC.
2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig (860 kPa).
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Compression inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 105 deg F (deg C).
9. Tempered-Water Design Flow Rate: 0.35 gpm (L/s).
10. Valve Finish: Chrome plated.

### B. Primary, Electronic, Water Mixing Valve Assemblies TMV-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Leonard Valve Co. product indicated on Drawings or comparable product by one of the following:
  - a. Acorn Engineering Company; a Division of Morris Group International.
  - b. Caleffi.
  - c. Leonard Valve Company.
  - d. POWERS; A WATTS Brand.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
4. Type: Exposed, electronically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded or solder joint inlets and outlet.
7. Accessories: Manual temperature override control, check stops on hot- and cold-water supplies, and automatic hot- and cold-water shutoff upon inlet supply failure.
8. Tempered-Water Setting: 125 deg F (deg C).
9. Tempered-Water Design Flow Rate: 13 gpm (L/s).



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10. Selected Valve Flow Rate at 45-psig (310-kPa) Pressure Drop: 45 gpm (L/s).
11. Pressure Drop at Design Flow Rate: 3 psig (kPa).
12. Valve Finish: Bronze.
13. Digital temperature control and monitoring module.
  - a. Controls temperature within plus or minus 2 deg F (1 deg C).
  - b. User programmable at module or through BAS.
  - c. ASHRAE 188 compliance.
  - d. 115 V ac, 60 Hz.

## 2.7 STRAINERS FOR DOMESTIC WATER PIPING

### A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Keckley Company.
  - b. Titan Flow Control, Inc.
  - c. WATTS.
  - d. Zurn Industries, LLC.
2. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
3. Body: Bronze for NPS 2 (DN 50) and smaller;.
4. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
5. Screen: Stainless steel with round perforations unless otherwise indicated.
6. Perforation Size:
  - a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
7. Drain: Pipe plug.

## 2.8 OUTLET BOXES

### A. Icemaker Outlet Boxes WSOB-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Guy Gray product indicated on Drawings or comparable product by one of the following:
  - a. LSP Products Group.
  - b. Oatey.
  - c. Sioux Chief Manufacturing Company, Inc.
  - d. Water-Tite, IPS Corporation.
2. Mounting: Recessed.
3. Material and Finish: Stainless steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.



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5. Supply Shutoff Fitting: NPS 1/2 (DN 15) gate, globe, or ball valve and NPS 1/2 (DN 15) copper, water tubing.

## 2.9 HOSE BIBBS

### A. Hose Bibbs HB-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Acorn Engineering product indicated on Drawings or comparable product by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. MIFAB, Inc.
  - c. Prier Products, Inc.
  - d. WATTS.
  - e. Woodford Manufacturing Company.
  - f. Zurn Industries, LLC.
2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig (860 kPa).
8. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Service Areas: Rough bronze.
11. Finish for Finished Rooms and Exterior Facade: Chrome or nickel plated.
12. Operation for Equipment Rooms: Wheel handle or operating key.
13. Operation for Service Areas: Wheel handle.
14. Operation for Finished Rooms and Building Facade: Operating key.
15. Include operating key with each operating-key hose bibb.
16. Include integral wall flange with each chrome- or nickel-plated hose bibb.

## 2.10 DRAIN VALVES

### A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.



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9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

## 2.11 WATER-HAMMER ARRESTERS

### A. Water-Hammer Arresters WHA-A, -B:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AMTROL, Inc.
  - b. Jay R. Smith Mfg Co; a division of Morris Group International.
  - c. Josam Company.
  - d. MIFAB, Inc.
  - e. Precision Plumbing Products.
  - f. Sioux Chief Manufacturing Company, Inc.
  - g. WATTS.
  - h. Zurn Industries, LLC.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

## 2.12 TRAP-SEAL PRIMER SYSTEMS

### A. Trap-Seal Primer Systems TP-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Precision Plumbing Products product indicated on Drawings or comparable product by one of the following:
  - a. Sioux Chief Manufacturing Company, Inc.
  - b. Zurn Industries, LLC.
2. Standard: ASSE 1044.
3. Inlet Size: NPS 3/4, ASTM B88, Type L (DN 20, ASTM B88M, Type B); copper, water tubing.
4. Cabinet: Recessed -mounted steel box with stainless steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120 V ac power.
  - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: Two.
8. Size Outlets: NPS 1/2 (DN 15).



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2.13 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Flex-Hose Co., Inc.
  - 2. Mason Industries, Inc.
  - 3. Metraflex Company (The).
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
  - 1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
  - 2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
- C. Stainless Steel-Hose Flexible Connectors: Corrugated-stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.
  - 1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
  - 2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
  - 1. Locate backflow preventers in same room as connected equipment or system.
  - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
  - 3. Do not install bypass piping around backflow preventers.
- B. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.
- C. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.
  - 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- D. Y-Pattern Strainers: For water, install on supply side of each pump.



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- E. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 1-1/2-by-3-1/2-inch (38-by-89-mm) fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 06 10 00 "Rough Carpentry."
- F. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.
- G. Trap-Seal Primer Systems: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

### 3.2 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

### 3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

### 3.4 CONTROL CONNECTIONS

- A. Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."

### 3.5 IDENTIFICATION

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Balancing valves.
  - 2. Temperature-actuated, water mixing valves.
  - 3. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in



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addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.6 ADJUSTING

- A. Set field-adjustable flow set points of balancing valves.
- B. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

**END OF SECTION 22 11 19**



## **SECTION 22 11 23.21 - INLINE, DOMESTIC-WATER PUMPS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. In-line, sealless centrifugal pumps.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals:
  - 1. Product Data: For pump controls.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Structural members to which pumps will be attached.
  - 2. Size and location of initial access modules for acoustical tile.
- B. Seismic Qualification Data: Certificates, for inline, domestic-water pumps, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.



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2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written instructions for handling.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: UL 778 for motor-operated water pumps.
- C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.
- D. Seismic Performance: Inline, domestic-water pumps shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.
  1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  2. Component Importance Factor: **1.5**



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2.2 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Flo Fab Inc.
  - 2. Grundfos Pumps Corp.
  - 3. Taco Comfort Solutions, Inc.
  - 4. WILO USA LLC - WILO Canada Inc.
- C. Capacities and Characteristics:
  - 1. Capacity: See plan schedule..
  - 2. Total Dynamic Head: See plan schedule.
  - 3. Inlet and Outlet Size: See plan schedule..
  - 4. Pump Speed: Variable.
  - 5. Pump Control: Timer.
  - 6. Motor Horsepower: See plan schedule.
  - 7. Electrical Characteristics:
    - a. Volts: 120 V.
    - b. Phase: Single phase.
    - c. Hertz: 60 Hz.
- D. Pump Construction:
  - 1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
  - 2. Minimum Working Pressure: 125 psig (860 kPa).
  - 3. Maximum Continuous Operating Temperature: 230 deg F.
  - 4. Casing: Stainless steel, with threaded or companion-flange connections.
  - 5. Impeller: composite.
  - 6. Motor: Single speed.
  - 7. .

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 "Common Motor Requirements for Plumbing Equipment."
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.



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## 2.4 CONTROLS

- A. Timers: Electric, for control of hot-water circulation pump.
  - 1. Type: Programmable, seven-day clock with manual override on-off switch.
  - 2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
  - 3. Operation of Pump: On or off.
  - 4. Transformer: Provide if required.
  - 5. Power Requirement: 120 V ac.
  - 6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

### 3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Mount pumps in orientation complying with manufacturer's written instructions.
- C. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.
  - 1. Comply with requirements for vibration isolation devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
  - 2. Comply with requirements for hangers and supports specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- D. Install timers adjacent to water heater.

### 3.3 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.



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- C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
- D. Install shutoff valve on suction side of each pump, and check, and shutoff, valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in the following:
  - 1. Section 22 05 23.12 "Ball Valves for Plumbing Piping."
  - 2. Section 22 05 23.14 "Check Valves for Plumbing Piping."

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between temperature controllers and devices.

3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.



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3.7      STARTUP SERVICE

- A.    Engage a factory-authorized service representative to perform startup service.
  - 1.    Complete installation and startup checks according to manufacturer's written instructions.
  - 2.    Check piping connections for tightness.
  - 3.    Clean strainers on suction piping.
  - 4.    Set timers, for automatic starting and stopping operation of pumps.
  - 5.    Perform the following startup checks for each pump before starting:
    - a.    Verify bearing lubrication.
    - b.    Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    - c.    Verify that pump is rotating in the correct direction.
  - 6.    Prime pump by opening suction valves and closing drains, and prepare pump for operation.
  - 7.    Start motor.
  - 8.    Open discharge valve slowly.
  - 9.    Adjust temperature settings on thermostats.
  - 10.   Adjust timer settings.

3.8      ADJUSTING

- A.    Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.
- B.    Adjust initial temperature set points.
- C.    Set field-adjustable switches and circuit-breaker trip ranges as indicated.

**END OF SECTION 22 11 23.21**



## **SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Hubless, cast-iron soil pipe and fittings.
  - 2. PVC pipe and fittings.
  - 3. Specialty pipe fittings.
  - 4. Encasement for underground metal piping.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
  - 1. Product Data: For adhesives, indicating VOC content.
- C. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.



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1.5 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AB & I Foundry; a part of the McWane family of companies.
  - 2. Charlotte Pipe and Foundry Company.
  - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: ASTM A 888 and CISPI 301.
- C. CISPI, Hubless-Piping Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ANACO-Husky.
    - b. Charlotte Pipe and Foundry Company.
    - c. Dallas Specialty & Mfg. Co.
    - d. Ideal Clamp Products, Inc.
    - e. Josam Company.
    - f. MIFAB, Inc.



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- g. Mission Rubber Company, LLC; a division of MCP Industries.
    - h. Tyler Pipe; a subsidiary of McWane Inc.
  - 2. Standards: ASTM C 1277 and CISPI 310.
  - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- D. Heavy-Duty, Hubless-Piping Couplings:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 2. ANACO-Husky.
    - a. Charlotte Pipe and Foundry Company.
    - b. Clamp-All Corp.
    - c. Ideal Clamp Products, Inc.
    - d. MIFAB, Inc.
    - e. Mission Rubber Company, LLC; a division of MCP Industries.
  - 3. Standards: ASTM C 1277 and ASTM C 1540.
  - 4. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

## 2.4 PVC PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.
  - 1. Verify adhesive primer has a VOC content of 550 g/L or less.
- E. Solvent Cement: ASTM D 2564.
  - 1. Verify solvent cement has a VOC content of 510 g/L or less.

## 2.5 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:



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1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
2. Shielded, Nonpressure Transition Couplings:
  - a. Standard: ASTM C 1460.
  - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Cascade Waterworks Mfg. Co.
    - 2) Mission Rubber Company, LLC; a division of MCP Industries.
  - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - d. End Connections: Same size as and compatible with pipes to be joined.

## 2.6 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A 674 or AWWA C105/A 21.5.
- B. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) or high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm) minimum thickness.
- C. Form: Sheet or tube.
- D. Color: Black or natural.

## PART 3 - EXECUTION

### 3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

### 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
  1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
  2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.



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- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
  - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
  - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
    - a. Straight tees, elbows, and crosses may be used on vent lines.
  - 3. Do not change direction of flow more than 90 degrees.
  - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    - a. Reducing size of waste piping in direction of flow is prohibited.
- K. Lay buried building waste piping beginning at low point of each system.
  - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
  - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
  - 3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
  - 1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 2 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
  - 2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
  - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.



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- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
  - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install aboveground PVC piping according to ASTM D 2665.
- O. Install underground PVC piping according to ASTM D 2321.
- P. Plumbing Specialties:
  - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
    - a. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
  - 2. Install drains in sanitary waste gravity-flow piping.
    - a. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors.
  - 1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs.
  - 1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors.
  - 1. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

### 3.3 JOINT CONSTRUCTION

- A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- B. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
  - 1. Cut threads full and clean using sharp dies.



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2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
  - c. Do not use pipe sections that have cracked or open welds.
- C. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

### 3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
  1. Install transition couplings at joints of piping with small differences in ODs.
  2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.

### 3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
  1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
  2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
  3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
  4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
  5. Vertical Piping: MSS Type 8 or Type 42, clamps.
  6. Install individual, straight, horizontal piping runs:
    - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
  7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.



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- C. Install hangers for **steel**soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.
- F. Support vertical runs of cast iron soil piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
  - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
  - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
  - 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
  - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
  - 5. Comply with requirements for cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
  - 6. Equipment: Connect waste piping as indicated.
    - a. Provide shutoff valve if indicated and union for each connection.
    - b. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.



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3.7 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
    - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
    - a. Expose work that was covered or concealed before it was tested.
  - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
    - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa).
    - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    - c. Inspect joints for leaks.
  - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.



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- a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa).
  - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
  - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
  - d. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  6. Prepare reports for tests and required corrective action.

### 3.9 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

### 3.10 PIPING SCHEDULE

- A. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following:
  1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
  2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- B. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be any of the following:
  1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
  3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be any of the following:



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1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

**END OF SECTION 22 13 16**



## **SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Cleanouts.
  - 2. Miscellaneous sanitary drainage piping specialties.
- B. Related Requirements:
  - 1. Section 07 62 00 "Sheet Metal Flashing and Trim" for metal roof flashing assemblies.
  - 2. Section 07 72 00 "Roof Accessories" for preformed flashings.
  - 3. Section 07 84 13 "Penetration Firestopping" for through-penetration firestop assemblies.
  - 4. Section 22 14 23 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

#### **1.3 DEFINITIONS**

- A. ABS: Acrylonitrile butadiene styrene.
- B. PVC: Polyvinyl chloride.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Show fabrication and installation details for frost-resistant vent terminals.



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1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 CLEANOUTS

- A. Cast-Iron Exposed Cleanouts:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Jay R. Smith Mfg Co; a division of Morris Group International.
    - b. Josam Company.
    - c. MIFAB, Inc.
    - d. Tyler Pipe; a subsidiary of McWane Inc.
    - e. WATTS.
    - f. Zurn Industries, LLC.
  - 2. Standard: ASME A112.36.2M.
  - 3. Size: Same as connected drainage piping
  - 4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
  - 5. Closure: Countersunk or raised-head, brass plug.
  - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- B. Cast-Iron Exposed Floor Cleanouts:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Jay R. Smith Mfg Co; a division of Morris Group International.
    - b. Josam Company.



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- c. MIFAB, Inc.
  - d. Sioux Chief Manufacturing Company, Inc.
  - e. WATTS.
  - f. Zurn Industries, LLC.
- 2. Standard: ASME A112.36.2M for adjustable housing cleanout.
  - 3. Size: Same as connected branch.
  - 4. Type: Adjustable housing.
  - 5. Body or Ferrule: Cast iron.
  - 6. Clamping Device: Not required.
  - 7. Outlet Connection: Inside calk.
  - 8. Closure: Brass plug with tapered threads.
  - 9. Adjustable Housing Material: Cast iron with threads.
  - 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
  - 11. Frame and Cover Shape: Round.
  - 12. Top-Loading Classification: Medium Duty.
  - 13. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. WATTS.
  - e. Zurn Industries, LLC.
- 3. Standard: ASME A112.36.2M. Include wall access.
- 4. Size: Same as connected drainage piping.
- 5. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
- 6. Closure Plug:
  - a. Brass.
  - b. Countersunk or raised head.
  - c. Drilled and threaded for cover attachment screw.
  - d. Size: Same as or not more than one size smaller than cleanout size.
- 7. Wall Access, Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings:



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1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
  2. Locate at each change in direction of piping greater than 45 degrees.
  3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
  4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
  1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
  2. Size: Same as floor drain inlet.
- E. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

#### 3.2 PIPING CONNECTIONS

- A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment, to allow service and maintenance.

#### 3.3 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.



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- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 22 13 19**



## **SECTION 22 13 19.13 - SANITARY DRAINS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Floor drains.
  - 2. Floor sinks.

#### **1.3 DEFINITIONS**

- A. ABS: Acrylonitrile-butadiene styrene.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene.
- D. PE: Polyethylene.
- E. PP: Polypropylene.
- F. PVC: Polyvinyl chloride.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

### **PART 2 - PRODUCTS**

#### **2.1 DRAIN ASSEMBLIES**

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.



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2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains FD-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn product indicated on Drawings or comparable product by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. WATTS.
  - e. Zurn Industries, LLC.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Not required.
8. Outlet: Bottom.
9. Coating on Interior and Exposed Exterior Surfaces: "Dura-coated".
10. Top or Strainer Material: Bronze.
11. Top of Body and Strainer Finish: Polished bronze.
12. Top Shape: Round.
13. Dimensions of Top or Strainer: Five inches.
14. Top Loading Classification: Light Duty.
15. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
16. Trap Material: Cast iron.
17. Trap Pattern: Standard P-trap.

2.3 FLOOR SINKS

A. Cast-Iron Floor Sinks FS-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn product indicated on Drawings or comparable product by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. Wade; a subsidiary of McWane Inc.
  - d. WATTS.
2. Standard: ASME A112.6.7.
3. Pattern: Floor drain.
4. Body Material: Cast iron.
5. Anchor Flange: Not required.
6. Clamping Device: Not required.
7. Outlet: Bottom, no-hub connection.
8. Coating on Interior Surfaces: Acid-resistant enamel.



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9. Sediment Bucket: Not required.
10. Internal Strainer: Dome.
11. Internal Strainer Material: Aluminum.
12. Top of Body and Grate Finish: Nickel bronze.
13. Top Shape: Square.
14. Dimensions of Top Grate: 12 inches, half-grate.
15. Top Loading Classification: No traffic.
16. Funnel: Not required..
17. .

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  1. Position floor drains for easy access and maintenance.
  2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
  3. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
  4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
    - a. Maintain integrity of waterproof membranes where penetrated.
  5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- B. Install open drain fittings with top of hub **2 inches (51 mm)** above floor.

#### 3.2 CONNECTIONS

- A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 22 13 19 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Install piping adjacent to equipment to allow service and maintenance.



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3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 22 13 19.13**



## **SECTION 22 14 13 - FACILITY STORM DRAINAGE PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Hubless, cast-iron soil pipe and fittings.
  - 2. PVC pipe and fittings.
  - 3. Encasement for underground metal piping.
- B. Related Requirements:
  - 1. Section 33 44 00 "Stormwater Utility Equipment" for storm drainage piping outside the building.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
  - 1. Product Data: For adhesives, indicating VOC content.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Structural members to which drainage piping will be attached or suspended from.
- B. Field quality-control reports.



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1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 FIELD CONDITIONS

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

- 1. Storm Drainage Piping: 10-foot head of water (30 kPa).

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. AB & I Foundry; a part of the McWane family of companies.
  - 2. Charlotte Pipe and Foundry Company.
  - 3. Tyler Pipe; a part of McWane family of companies.

- B. Pipe and Fittings:

- 1. Marked with CISPI collective trademark and NSF certification mark.
  - 2. Standard: ASTM A 888 or CISPI 301.

- C. CISPI, Hubless-Piping Couplings:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ANACO-Husky.
    - b. Charlotte Pipe and Foundry Company.
    - c. Dallas Specialty & Mfg. Co.
    - d. Ideal Clamp Products, Inc.
    - e. MIFAB, Inc.
    - f. Mission Rubber Company, LLC; a division of MCP Industries.
  - 2. Couplings shall bear CISPI collective trademark and NSF certification mark.
  - 3. Standards: ASTM C 1277 and CISPI 310..
  - 4. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.



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D. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ANACO-Husky.
  - b. Clamp-All Corp.
  - c. Ideal Clamp Products, Inc.
  - d. MIFAB, Inc.
  - e. Mission Rubber Company, LLC; a division of MCP Industries.
2. Standard: ASTM C 1540..
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Charlotte Pipe and Foundry Company.
  2. GF Piping Systems.
  3. JM Eagle; J-M Manufacturing Co., Inc.
  4. Mueller Industries, Inc.
  5. National Pipe and Plastic, Inc.
  6. North America Pipe Corporation.
  7. Rocky Mountain Colby Pipe Company.
  8. Silver-line Plastics.
- B. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
- C. Solid-Wall PVC Pipe: ASTM D 2665; drain, waste, and vent.
- D. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- E. Adhesive Primer: ASTM F 656.
1. Verify adhesive primer has a VOC content of 550 g/L or less.
- F. Solvent Cement: ASTM D 2564.
1. Verify solvent cement has a VOC content of 510 g/L or less.



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2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Shielded, Nonpressure Transition Couplings:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Cascade Waterworks Mfg. Co.
    - 2) Mission Rubber Company, LLC; a division of MCP Industries.
  - b. Standard: ASTM C 1460.
  - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - d. End Connections: Same size as and compatible with pipes to be joined.

2.5 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A 674 or AWWA C105/A 21.5.
- B. Material: High-density, crosslaminated polyethylene film of 0.004-inch (0.10-mm) or linear low-density polyethylene film of 0.008-inch (0.20-mm) minimum thickness.
- C. Form: Sheet or tube.
- D. Color: Black or natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
  1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.



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2. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- J. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
  1. Do not change direction of flow more than 90 degrees.
  2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    - a. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building piping beginning at low point of each system.
  1. Install true to grades and alignment indicated, with unbroken continuity of invert.
  2. Maintain swab in piping and pull past each joint as completed.
- L. Install piping at the following minimum slopes unless otherwise indicated:
  1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 2 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
  2. Horizontal Storm Drainage Piping: 2 percent downward in direction of flow.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."



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1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
  - N. Install aboveground PVC piping according to ASTM D 2665.
  - O. Install underground PVC piping according to ASTM D 2321.
  - P. Plumbing Specialties:
    1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
      - a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
      - b. Comply with requirements for cleanouts specified in Section 22 14 23 "Storm Drainage Piping Specialties."
    2. Install drains in storm drainage gravity-flow piping.
      - a. Comply with requirements for drains specified in Section 22 14 23 "Storm Drainage Piping Specialties."
  - Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
  - R. Install sleeves for piping penetrations of walls, ceilings, and floors.
    1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
  - S. Install sleeve seals for piping penetrations of concrete walls and slabs.
    1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
  - T. Install escutcheons for piping penetrations of walls, ceilings, and floors.
    1. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- 3.3 JOINT CONSTRUCTION
- A. Hubless, Cast-Iron Soil Piping Coupled Joints:
    1. Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
  - B. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:



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1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendices.

C. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
  - a. Provide axial restraint for pipe and fittings 5 inches (125 mm) and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
  - b. Provide rigid sway bracing for pipe and fittings 5 inches (125 mm) and larger, upstream and downstream of all changes in direction and branch openings.

### 3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

### 3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:
  - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.

C. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.



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- D. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.
- F. Support vertical cast-iron piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.
- G. Support vertical PVC piping with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
  - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
  - 2. Comply with requirements for cleanouts and drains specified in Section 22 14 23 "Storm Drainage Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance.

### 3.7 IDENTIFICATION

- A. Identify exposed storm drainage piping.
- B. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

### 3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.



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2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
    - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.
    - a. Expose work that was covered or concealed before it was tested.
  3. Test Procedure:
    - a. Test storm drainage piping on completion of roughing-in.
    - b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
  4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  5. Prepare reports for tests and required corrective action.
- C. Piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.9 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

### 3.10 PIPING SCHEDULE

- A. Aboveground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:
  1. Hubless, cast-iron soil pipe and fittings; **CISPI, heavy-duty**, hubless-piping couplings; and coupled joints.
  2. Galvanized-steel pipe, drainage fittings, and threaded joints.



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3. Copper Type DWV tube, copper drainage fittings, and soldered joints.
  4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- B. Aboveground, storm drainage piping NPS 8 (DN 200) and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
  3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Underground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
  2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- D. Underground, storm drainage piping NPS 8 (DN 200) and larger shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
  2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

**END OF SECTION 22 14 13**



## **SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Metal roof drains.
  - 2. Cleanouts.
  - 3. Channel drainage systems.
- B. Related Requirements:
  - 1. Section 07 62 00 "Sheet Metal Flashing and Trim" for penetrations of roofs.
  - 2. Section 07 84 13 "Penetration Firestopping" for firestopping roof penetrations.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

#### **1.4 QUALITY ASSURANCE**

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

### **PART 2 - PRODUCTS**

#### **2.1 METAL ROOF DRAINS**

- A. Cast-Iron, Large-Sump, General-Purpose Roof Drains RD-1:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn product indicated on Drawings or comparable product by one of the following:
    - a. Jay R. Smith Mfg Co; a division of Morris Group International.
    - b. Josam Company.



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- c. MIFAB, Inc.
  - d. Sioux Chief Manufacturing Company, Inc.
  - e. Wade; a subsidiary of McWane Inc.
  - f. WATTS.
  - g. Zurn Industries, LLC.
- 2. Standard: ASME A112.6.4.
  - 3. Body Material: Cast iron.
  - 4. Dimension of Body: Nominal 14-to 16-inch (357- to 406-mm) diameter.
  - 5. Combination Flashing Ring and Gravel Stop: Required.
  - 6. Flow-Control Weirs: Not required.
  - 7. Outlet: Bottom.
  - 8. Outlet Type: No hub.
  - 9. Extension Collars: Required.
  - 10. Underdeck Clamp: Not required.
  - 11. Expansion Joint: Not required.
  - 12. Sump Receiver Plate: Required.
  - 13. Dome Material: Cast iron.
  - 14. Perforated Gravel Guard: Not required.
  - 15. Vandal-Proof Dome: Not required.
  - 16. Water Dam: Not required.
  - 17. Top set deck plate: Required.

B. Cast-Iron, Large-Sump, General-Purpose Roof Drains ORD-1:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn product indicated on Drawings or comparable product by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Sioux Chief Manufacturing Company, Inc.
  - e. Wade; a subsidiary of McWane Inc.
  - f. WATTS.
  - g. Zurn Industries, LLC.
- 2. Standard: ASME A112.6.4.
- 3. Body Material: Cast iron.
- 4. Dimension of Body: Nominal 14-to 16-inch (357- to 406-mm) diameter.
- 5. Combination Flashing Ring and Gravel Stop: Required.
- 6. Flow-Control Weirs: Not required.
- 7. Outlet: Bottom.
- 8. Outlet Type: No hub.
- 9. Extension Collars: Required.
- 10. Underdeck Clamp: Not required.
- 11. Expansion Joint: Not required.
- 12. Sump Receiver Plate: Not required.
- 13. Dome Material: Cast iron.
- 14. Perforated Gravel Guard: Not required.



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15. Vandal-Proof Dome: Not required.
16. Water Dam: 2 inches (50 mm) high.
17. Top set deck plate: Required.

## 2.2 CLEANOUTS

### A. Cast-Iron Exposed Cleanouts

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Tyler Pipe; a subsidiary of McWane Inc.
  - e. Wade; a subsidiary of McWane Inc.
  - f. WATTS.
  - g. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body Material **No-hub, cast-iron soil pipe test tee** as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

### B. Cast-Iron Exposed Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. Sioux Chief Manufacturing Company, Inc.
  - d. Tyler Pipe; a subsidiary of McWane Inc.
  - e. Wade; a subsidiary of McWane Inc.
  - f. WATTS.
  - g. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Type: Adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: No hub.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.



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12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Tyler Pipe; a subsidiary of McWane Inc.
  - e. Wade; a subsidiary of McWane Inc.
  - f. WATTS.
  - g. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: No-hub, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:
  - a. Brass.
  - b. raised head.
  - c. Drilled and threaded for cover attachment screw.
  - d. Size: Same as, or not more than, one size smaller than cleanout size.
6. Wall Access, Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.

D. Test Tees:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Tyler Pipe; a subsidiary of McWane Inc.
  - e. WATTS.
  - f. Zurn Industries, LLC.
3. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301.
4. Size: Same as connected drainage piping.
5. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
6. Closure Plug: Countersunk or raised head, brass.
7. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.



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## 2.3 CHANNEL DRAINAGE SYSTEMS

### A. Narrow, Sloped-Invert, HDPE Polymer, Channel Drainage Systems TD-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn product indicated on Drawings or comparable product by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Mea-Josam Div.
  - c. MultiDrain Systems, Inc.
2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
  - a. Channel Sections: Narrow, interlocking-joint, sloped-invert, HDPE polymer-modular units with end caps.
    - 1) Include rounded bottom, with built-in invert slope of 0.75 percent and with outlets in number, sizes, and locations indicated.
    - 2) Include extension sections necessary for required depth.
    - 3) Dimensions: 4-inch inside width and 3.5-inches inside depth. Include number of units required to form total lengths indicated.
    - 4) Frame: Not required.
  - b. Grates: Manufacturer's designation "medium duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
    - 1) Material: Stainless steel.
    - 2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
  - c. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
  - d. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install roof drains at low points of roof areas in accordance with roof membrane manufacturer's written installation instructions.
  1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
  2. Install expansion joints, if indicated, in roof drain outlets.
  3. Position roof drains for easy access and maintenance.
- B. Install cleanouts in aboveground piping and building drain piping in accordance with the following instructions unless otherwise indicated:



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1. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
  2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
  3. Locate cleanouts at minimum intervals of 100 feet for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
  4. Locate cleanouts at base of each vertical storm piping conductor.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install test tees in vertical conductors and near floor.
- F. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- G. Assemble channel drainage system components in accordance with manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- H. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.
1. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

### 3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 14 13 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

### 3.3 INSTALLATION OF FLASHING

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.



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3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 22 14 23**



## **SECTION 22 33 00 - ELECTRIC, DOMESTIC-WATER HEATERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Commercial, electric, storage, domestic-water heaters.
  - 2. Domestic-water heater accessories.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals:
  - 1. Product Data: For energy efficiency.
- C. Shop Drawings:
  - 1. Include diagrams for power, signal, and control wiring.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.
- B. Seismic Qualification Data: Certificates, for commercial domestic-water heaters, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.



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- 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Product Certificates: For each type of commercial, electric, domestic-water heater.
- D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
- 1. Failures include, but are not limited to, the following:
    - a. Structural failures including storage tank and supports.
    - b. Faulty operation of controls.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
  - 2. Warranty Periods: From date of Substantial Completion.
    - a. Commercial, Electric, Storage, Domestic-Water Heaters:
      - 1) Storage Tank: Three years.
      - 2) Controls and Other Components: one years.
    - b. Expansion Tanks: Five years.



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PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. Seismic Performance: Commercial, electric, domestic-water heaters shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Component Importance Factor: 1.0.
  - 3.
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- D. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- E. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

- A. Commercial, Electric, Storage, Domestic-Water Heaters, WH-1, WH-2:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide A.O.Smith product indicated on Drawings or comparable product by one of the following:
    - a. Bradford White Corporation.
    - b. Lochinvar, LLC.
    - c. PVI; A WATTS Brand.
    - d. Rheem Manufacturing Company.
    - e. State Industries.
  - 2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
  - 3. Standard: UL 1453.
  - 4. Storage-Tank Construction: ASME-code, steel vertical arrangement.
    - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
      - 1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.



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- 2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges, and in accordance with ASME B16.24 for copper and copper-alloy flanges.
  - b. Pressure Rating: 150 psig (1035 kPa).
  - c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
- 5. Factory-Installed, Storage-Tank Appurtenances:
  - a. Anode Rod: Replaceable magnesium.
  - b. Drain Valve: Corrosion-resistant metal with hose-end connection.
  - c. Insulation: Comply with ASHRAE/IES 90.1.
  - d. Jacket: Steel with enameled finish or high-impact composite material.
  - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
  - f. Temperature Control: Adjustable thermostat.
  - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
  - h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.
- B. Capacity and Characteristics:
  - 1. Capacity: See plan schedule.
  - 2. Recovery: See plan schedule t for temperature rise.
  - 3. Temperature Setting: 140 deg F (60 deg C).
  - 4. Power Demand: See plan schedule..
  - 5. Heating Elements:
    - a. Number of Elements: Three per immersion heater.
    - b. Kilowatts Each Heater: See plan schedule..
    - c. Number of Stages: One.
  - 6. Electrical Characteristics:
    - a. Volts: 208 V V.
    - b. Phases: Three.
    - c. Hertz: 60 Hz.
    - d. Full-Load Amperes: WH-1, 59.1; WH-2, 28.8 A.

## 2.3 DOMESTIC-WATER HEATER ACCESSORIES

### A. Domestic-Water Expansion Tanks:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Amtrol product indicated on Drawings or comparable product by one of the following:
  - a. A. O. Smith Corporation.



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- b. Flexcon Industries.
    - c.
    - d. Pentair Pump Group.
    - e. State Industries.
    - f. Taco Comfort Solutions, Inc.
  - 2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
  - 3. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
  - 4. Construction:
    - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    - b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    - c. Air-Charging Valve: Factory installed.
  - 5. Capacity and Characteristics:
    - a. Working-Pressure Rating: 150 psig (1035 kPa).
    - b. Capacity Acceptable: 2 gal. (7.6 L) minimum.
    - c. Air Precharge Pressure: 70 psi.
  - B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads.
  - C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.
  - D. Heat-Trap Fittings: ASHRAE/IES 90.1.
  - E. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.
- 2.4 SOURCE QUALITY CONTROL
- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.
  - B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
  - C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.



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- D. Prepare test and inspection reports.

### PART 3 - EXECUTION

#### 3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 03 30 00 "Cast-in-Place Concrete."
1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
  2. Maintain manufacturer's recommended clearances.
  3. Arrange units so controls and devices that require servicing are accessible.
  4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
  5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  7. Install anchor bolts to elevations required for proper attachment to supported equipment.
  8. Anchor domestic-water heaters to substrate.
- B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping."
- C. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with



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requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

- F. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- G. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- H. Fill electric, domestic-water heaters with water.
- I. Charge domestic-water expansion tanks with air to required system pressure.
- J. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

### 3.2 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

### 3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.



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- 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
- 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. commercial, electric, domestic-water heaters. Training shall be a minimum of one hour(s).

**END OF SECTION 22 33 00**



## **SECTION 22 42 13.13 - COMMERCIAL WATER CLOSETS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Wall-mounted water closets.
  - 2. Flushometer valves.
  - 3. Toilet seats.
  - 4. Supports.

#### **1.2 DEFINITIONS**

- A. Standard-Efficiency Flush Volume: 1.6 gal. (6 L) per flush.
- B. High-Efficiency Flush Volume: 1.28 gal. (4.8 L) or less per flush.
- C. WaterSense Fixture: Water closet and/or flushometer valve/tank certified by the EPA to meet the WaterSense performance criteria.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data:
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power and control wiring.
- C. Sustainable Design Submittals:
  - 1. Product Data: For water consumption.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.



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1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Standards:
1. Comply with ASME A112.19.2/CSA B45.1 for water closets.
  2. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets and tanks.
  3. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
  4. Comply with IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
  5. Comply with ASME A112.6.1M for water-closet supports.
  6. Comply with ICC A117.1 for ADA-compliant water closets.
  7. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous china water closets to sanitary drainage systems.
  8. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous china water closets to sanitary drainage systems.

2.2 WALL-MOUNTED WATER CLOSETS

- A. Water Closets - Wall Mounted, Top Spud: WC-1, WC-2.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Kohler product indicated on Drawings or comparable product by one of the following:
    - a. American Standard.
    - b. Gerber Plumbing Fixtures LLC.
    - c. Mansfield Plumbing Products LLC.
    - d. Sloan Valve Company.
    - e. TOTO USA, INC.
    - f. Zurn Industries, LLC.
  2. Source Limitations: Obtain water closets from single source from single manufacturer.
  3. Bowl:
    - a. Material: Vitreous china.
    - b. Type: Siphon jet.



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- c. Style: Flushometer valve.
  - d. Mounting Height: WC-1, Standard; WC-2, ADA compliant.
  - e. Rim Contour: Elongated.
  - f. Water Consumption: 1.1 gal. (4.2 L) per flush.
  - g. Spud Size and Location: NPS 1-1/2 (DN 40); top.
  - h. Color: White.
- 4. Flushometer Valve: WC.
  - 5. Toilet Seat: WC.
  - 6. Support: Water-closet carrier.

## 2.3 FLUSHOMETER VALVES

### A. Flushometer Valves - Piston, Sensor Operated, Battery Powered: WC.

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn product indicated on Drawings or comparable product by one of the following:
  - a. American Standard.
  - b. Hydrotek International, Inc.
  - c. Kohler Co.
  - d. Moen Incorporated.
  - e. Sloan Valve Company.
  - f. TOTO USA, INC.
- 2. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
- 3. Minimum Pressure Rating: 125 psig (860 kPa).
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
- 6. Style: Exposed.
- 7. Exposed Flushometer-Valve Finish: Chrome-plated.
- 8. Trip Mechanism: Battery-powered electronic sensor; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
- 9. Consumption: 1.1 gal (4.2 L) per flush.
- 10. Minimum Inlet: NPS 1 (DN 25).
- 11. Minimum Outlet: NPS 1-1/4 (DN 32).

## 2.4 TOILET SEATS

### A. Toilet Seats: WC.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. American Standard.



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- b. Bemis Manufacturing Company.
  - c. Centoco Manufacturing Corporation.
  - d. Church Seats; Bemis Manufacturing Company.
  - e. Jones Stephens Corp.
  - f. Kohler Co.
  - g. TOTO USA, INC.
  - h. Zurn Industries, LLC.
- 3. Source Limitations: Obtain toilet seat from single source from single manufacturer.
  - 4. Material: Plastic.
  - 5. Type: Commercial (Heavy duty).
  - 6. Shape: Elongated rim, open front.
  - 7. Hinge: Self-sustaining, check.
  - 8. Hinge Material: Noncorroding metal.
  - 9. Seat Cover: Not required.
  - 10. Color: White.
  - 11. Surface Treatment: Antimicrobial.

## 2.5 SUPPORTS

### A. Water-Closet Carrier:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Wade Drains.
  - e. WATTS.
  - f. Zurn Industries, LLC.
- 2. Source Limitations: Obtain water-closet carrier from single source from single manufacturer.
- 3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.



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- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Water-Closet Installation:

1. Install level and plumb.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.

B. Support Installation:

1. Use carrier supports with waste-fitting assembly and seal.
2. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
3. Measure support height installation from finished floor, not structural floor.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install actuators in locations easily reachable for people with disabilities.
4. Install new batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."



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3.3 PIPING CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

**END OF SECTION 22 42 13.13**



## **SECTION 22 42 13.16 - COMMERCIAL URINALS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Wall-hung urinals.
  - 2. Urinal flushometer valves.
  - 3. Supports.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals:
  - 1. Product Data: For water consumption.
- C. Shop Drawings: Include diagrams for power, signal, and control wiring.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

#### **1.5 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.



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1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

## PART 2 - PRODUCTS

### 2.1 STALL URINALS

#### A. Urinals - Stall, Washout Type

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. American Standard.
  - b. Kohler Co.
  - c. Zurn Industries, LLC.
3. Fixture:
  - a. Standards: ASME A112.19.2/CSA B45.1 and  
ASME A112.19.5/CSA B45.15.
  - b. Material: Vitreous china.
  - c. Type: **Straight** front.
  - d. Seam Covers: For **24-inch (610-mm)** urinal centers.
  - e. Strainer: Separate; removable.
  - f. Water Consumption: **0.125 gpf (0.5 Lpf)**.
  - g. Spud Size and Location: NPS 3/4 (DN 20); top.
  - h. Outlet Size and Location: NPS 2 (DN 50); bottom for separate trap.
  - i. Color: **White**

### 2.2 WALL-HUNG URINALS

#### A. Urinals - Wall Hung, Back Outlet, Washout: U-1, U-2.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Kohler product indicated on Drawings or comparable product by one of the following:
  - a. American Standard.
  - b. Gerber Plumbing Fixtures LLC.
  - c. Mansfield Plumbing Products LLC.
  - d. TOTO USA, INC.
  - e. Zurn Industries, LLC.
2. Fixture:
  - a. Standards: ASME A112.19.2/CSA B45.1 and  
ASME A112.19.5/CSA B45.15.
  - b. Material: Vitreous china.



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- c. Type: Washout with extended shields.
  - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
  - e. Water Consumption: 0.125 gpf (0.5 Lpf).
  - f. Spud Size and Location: NPS 3/4 (DN 20), top.
  - g. Outlet Size and Location: NPS 2 (DN 50), back.
  - h. Color: White.
- 3. Flushometer Valve: Urinal flushometer-valve designation from "Urinal Flushometer Valves" Article.
  - 4. Waste Fitting:
    - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
    - b. Size: NPS 2 (DN 50).
  - 5. Support: Type I urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.
  - 6. Urinal Mounting Height: U-1 Standard; U-2 Handicapped/elderly according to ICC A117.1.

## 2.3 URINAL FLUSHOMETER VALVES

### A. Battery-Powered, Solenoid-Actuator, Piston Flushometer Valves: URINAL.

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn product indicated on Drawings or comparable product by one of the following:
  - a. American Standard.
  - b. Delany Products.
  - c. Hydrotek International, Inc.
  - d. Kohler Co.
  - e. Sloan Valve Company.
  - f. TOTO USA, INC.
- 2. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
- 3. Minimum Pressure Rating: 125 psig (860 kPa).
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
- 6. Exposed Flushometer-Valve Finish: Chrome plated.
- 7. Style: Exposed.
- 8. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
- 9. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
- 10. Consumption: 0.125 gal. per flush.
- 11. Minimum Inlet: NPS 3/4 (DN 20).
- 12. Minimum Outlet: NPS 3/4 (DN 20).



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2.4 SUPPORTS

- A. Type I Urinal Carrier, with lower bearing plate:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Jay R. Smith Mfg Co; a division of Morris Group International.
    - b. Josam Company.
    - c. MIFAB, Inc.
    - d. Wade Drains.
    - e. WATTS.
    - f. Zurn Industries, LLC.
  - 2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Urinal Installation:
  - 1. Install urinals level and plumb according to rough-in drawings.
  - 2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
  - 3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC A117.1.
- B. Support Installation:
  - 1. Install supports, affixed to building substrate, for wall-hung urinals.
  - 2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
- C. Flushometer-Valve Installation:
  - 1. Install flushometer-valve water-supply fitting on each supply to each urinal.
  - 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.



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3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
4. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

E. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

### 3.3 PIPING CONNECTIONS

- A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

### 3.4 ADJUSTING

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

### 3.5 CLEANING AND PROTECTION

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.



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- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

**END OF SECTION 22 42 13.16**



## **SECTION 22 42 16.13 - COMMERCIAL LAVATORIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Vitreous-china, counter-mounted lavatories.
  - 2. Vitreous-china, wall-mounted lavatories.
  - 3. Automatically operated lavatory faucets.
  - 4. Supply fittings.
  - 5. Waste fittings.
  - 6. Lavatory supports.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals:
  - 1. Product Data: For water consumption.
- C. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.



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1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.
  - 1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
    - a. Servicing and adjustments of automatic faucets.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
  - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

- A. Lavatory - Vitreous China, Undercounter Mounted L-1:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Kohler product indicated on Drawings or comparable product by one of the following:
    - a. American Standard.
    - b. Mansfield Plumbing Products LLC.
    - c. Sloan Valve Company.
    - d. TOTO USA, INC.
    - e. Zurn Industries, LLC.
  - 2. Fixture:
    - a. Standard: ASME A112.19.2/CSA B45.1.
    - b. Type: For undercounter mounting.
    - c. Nominal Size: Oval, 21 by 17 inches.
    - d. Faucet-Hole Punching: No holes.
    - e. Faucet-Hole Location: On countertop.
    - f. Color: White.
    - g. Mounting Material: Sealant and undercounter mounting kit.
  - 3. Faucet: Lav lavatory faucet designation from "Automatically Operated Lavatory Faucets" Article.



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2.2 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory - Vitreous China, Wall Mounted, with Back L-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Kohler product indicated on Drawings or comparable product by one of the following:
  - a. American Standard.
  - b. Mansfield Plumbing Products LLC.
  - c. Sloan Valve Company.
  - d. Zurn Industries, LLC.
2. Fixture:
  - a. Standard: ASME A112.19.2/CSA B45.1.
  - b. Type: For wall hanging.
  - c. Nominal Size: Rectangular, 21 by 18 inches.
  - d. Faucet-Hole Punching: One hole.
  - e. Faucet-Hole Location: Top.
  - f. Color: White.
  - g. Mounting Material: Chair carrier.
3. Faucet: Lav faucet designation from "Automatically Operated Lavatory Faucets" Article.
4. Support: Type II, concealed-arm lavatory carrier with escutcheons. Include rectangular, steel uprights.
5. Lavatory Mounting Height:**sure**

2.3 AUTOMATICALLY OPERATED LAVATORY FAUCETS

- A. Lavatory faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372, or be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI) accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Lavatory Faucets - Automatic Type: Self-sustaining power generating, Battery back-up Electronic Sensor Operated, Nonmixing, LAV:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn product indicated on Drawings or comparable product by one of the following:
    - a. Advanced Modern Technologies Corporation - AMTC.
    - b. Chicago Faucets; Geberit Company.
    - c. Moen Incorporated.
    - d. Sloan Valve Company.
    - e. Speakman Company.
    - f. TOTO USA, INC.
    - g. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.



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2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. General: Coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
4. Body Type: Single hole.
5. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 0.35 gpm.
8. Mounting Type: Deck, concealed.
9. Spout: Rigid type.
10. Spout Outlet: Spray.
11. Drain: Not part of faucet.

#### 2.4 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type valve with inlet connection matching supply piping.
- E. Operation: Wheel handle.
- F. Risers:
  1. NPS 3/8 (DN 10).
  2. ASME A112.18.6/CSA B125.6, braided- or corrugated-stainless steel, flexible hose riser.

#### 2.5 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 (DN 32) offset and straight tailpiece.
- C. Trap:
  1. Size: NPS 1-1/4 (DN 32).
  2. Material:



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- a. Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall; and chrome-plated, brass or steel wall flange.

## 2.6 LAVATORY SUPPORTS

### A. Lavatory Carrier:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Wade; a subsidiary of McWane Inc.
  - e. WATTS.
  - f. Zurn Industries, LLC.
- 2. Standard: ASME A112.6.1M.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install lavatories level and plumb in accordance with roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, in accordance with ICC A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."



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- E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

3.3 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

**END OF SECTION 22 42 16.13**



## SECTION 22 42 16.16 - COMMERCIAL SINKS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Service sinks.
2. Kitchen/utility sinks.
3. Manually operated sink faucets.
4. Supply fittings.
5. Waste fittings.
6. Sink supports.
7. Grout.

- B. Related Requirements:

1. Section 11 40 00 "Foodservice Equipment" for NSF-compliant foodservice and handwash sinks.
2. Section 22 41 00 "Residential Plumbing Fixtures" for residential sinks.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
2. Include rated capacities, operating characteristics, **electrical characteristics**, and furnished specialties and accessories.

- B. Sustainable Design Submittals:

1. Product Data: For water consumption.



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1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted sinks.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sinks and faucets to include in operation and maintenance manuals.

- 1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
  - a. Servicing and adjustments for automatic faucets.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
  - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 SERVICE SINKS

- A. Service Sinks - Terrazzo, Floor Mounted: MS-1.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Acorn Engineering Company; a Division of Morris Group International.
    - b. Florestone Products Co., Inc.
    - c. Stern-Williams Co., Inc.
  - 2. Source Limitations: Obtain sinks from single source from single manufacturer.
  - 3. Fixture:
    - a. Material: Marble chips cast in portland cement to produce a compressive strength of not less than 3000 psi (20.7 MPa), seven days after casting.
    - b. Shape: Radial front.
    - c. Nominal Size: 28 by 28 inches.
    - d. Height: 12 inches (305 mm) with dropped front.
    - e. Tiling Flange: On two sides.
    - f. Rim Guard: On front top surfaces.



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- g. Color: Not applicable.
- h. Drain: Grid with NPS 2 (DN 50) outlet.
- 4. Mounting: On floor and flush to wall.
- 5. Faucet: MS service sink faucet designation from "Manually Operated Sink Faucets" Article.

## 2.2 KITCHEN/UTILITY SINKS

### A. Kitchen/Utility Sinks - Stainless Steel, Counter Mounted: S-1, S-3.

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Kohler product indicated on Drawings or comparable product by one of the following:
  - a. Elkay.
  - b. Franke.
  - c. Just Manufacturing.
- 2. Source Limitations: Obtain sinks from single source from single manufacturer.
- 3. Fixture:
  - a. Standard: ASME A112.19.3/CSA B45.4.
  - b. Type: Stainless steel, under-counter mount, sound-deadened unit less ledge back.
  - c. Number of Compartments: One.
  - d. Overall Dimensions: 18 by 24 inches.
  - e. Material: 16 gauge, Type 304 stainless steel.
  - f. Compartment:
    - 1) Dimensions: 22-1/4 by 16-1/2 by 9-5/16 inches.
    - 2) S-3 Drain: Basket strainer with NPS 1-1/2 (DN 40) tailpiece and twist drain.
    - 3) S-1 Drain: Mount for garbage disposer.
    - 4) Drain Location: Near back of compartment.
    - 5) Depth: Standard.
- 4. Faucet(s): S-1 sink faucet designation from "Manually Operated Sink Faucets" .
  - a. Number Required: One.
  - b. Mounting: On ledge.
- 5. Supply Fittings:
  - a. Standard: ASME A112.18.1/CSA B125.1.
  - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
    - 1) Operation: Wheel handle.
    - 2) Risers: NPS 1/2 (DN 15), ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.



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6. Waste Fittings:
  - a. Standard: ASME A112.18.2/CSA B125.2.
  - b. Trap(s):
    - 1) Size: NPS 1-1/2 (DN 40).
    - 2) Material:
      - a) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall ; and chrome-plated brass or steel wall flange.
  - c. Continuous Waste:
    - 1) Size: NPS 1-1/2 (DN 40).
    - 2) Material: Chrome-plated, 17-gauge brass tube.

7. Mounting: On counter with sealant.

B. Kitchen/Utility Sinks - Stainless Steel, Counter Mounted: S-4.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay product indicated on Drawings or comparable product by one of the following:
  - a. Elkay.
  - b. Franke.
  - c. Just Manufacturing.
2. Source Limitations: Obtain sinks from single source from single manufacturer.
3. Fixture:
  - a. Standard: ASME A112.19.3/CSA B45.4.
  - b. Type: Stainless steel, counter mount, sound-deadened unit with ledge back.
  - c. Number of Compartments: One.
  - d. Overall Dimensions: 19-1/2 by 22 inches.
  - e. Material: 18 gauge, Type 304 stainless steel.
  - f. Compartment:
    - 1) Dimensions: 16 by 16 by 5-1/2 inches.
    - 2) Drain: Basket strainer with NPS 1-1/2 (DN 40) tailpiece and twist drain.
    - 3) Drain Location: Near back of compartment.
    - 4) Depth: Accessible.
4. Faucet(s): S-1 sink faucet designation from "Manually Operated Sink Faucets" .
  - a. Number Required: One.
  - b. Mounting: On ledge.
5. Supply Fittings:
  - a. Standard: ASME A112.18.1/CSA B125.1.
  - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.



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- 1) Operation: Wheel handle.
6. Risers: NPS 1/2 (DN 15),
  - 1) ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.
7. Waste Fittings:
  - a. Standard: ASME A112.18.2/CSA B125.2.
  - b. Trap(s):
    - 1) Size: NPS 1-1/2 (DN 40).
    - 2) Material:
      - a) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall ; and chrome-plated brass or steel wall flange.
  - c. Continuous Waste:
    - 1) Size: NPS 1-1/2 (DN 40).
    - 2) Material: Chrome-plated, 17-gauge brass tube.
8. Mounting: On counter with sealant.
- C. Kitchen/Utility Sinks - Stainless Steel, Freestanding: S-2.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Advanced Tabco product indicated on Drawings or comparable product by one of the following:
    - a. AERO Manufacturing Company.
    - b. Amtekco Industries, Inc; a Wasserstrom Company.
    - c. Eagle Group.
    - d. Elkay.
    - e. Franke.
    - f. Griffin Products, Inc.
    - g. Just Manufacturing.
  2. Source Limitations: Obtain sinks from single source from single manufacturer.
  3. Fixture:
    - a. Standards:
      - 1) ASME A112.19.3/CSA B45.4.
      - 2) NSF 2.
    - b. Type: Stainless steel, freestanding, sound-deadened unit with backsplash.
    - c. Number of Compartments: Three.
    - d. Overall Dimensions: 97 by 32 inches.
    - e. Material: 16 gauge, Type 304 stainless steel.
    - f. Each Compartment:
      - 1) Dimensions: 24 by 18 inches.



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- 2) Drains: Grid with NPS 1-1/2 (DN 40) tailpiece and twist drain.
    - 3) Drain Location: Centered in compartment.
    - g. Integral Drainboard(s): Both side(s).
      - 1) Dimensions Each: 18 inches.
  - 4. Legs and Feet: Stainless steel tubing legs with adjustable bullet feet.
  - 5. Faucet(s): S-2 sink faucet designation from "Manually Operated Sink Faucets" .
    - a. Number Required: One.
    - b. Mounting: On backsplash.
  - 6. Supply Fittings:
    - a. Standard: ASME A112.18.1/CSA B125.1.
    - b. Supplies: Chrome-plated brass quarter turn ball stop with inlet connection matching water-supply piping type and size.
      - 1) Operation: Wheel handle.
      - 2) Risers: NPS 1/2 (DN 15), ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.
  - 7. Waste Fittings:
    - a. Standard: ASME A112.18.2/CSA B125.2.
    - b. Trap(s):
      - 1) Size: NPS 1-1/2 (DN 40).
      - 2) Material:
        - a) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.
    - c. Continuous Waste:
      - 1) Size: NPS 1-1/2 (DN 40).
      - 2) Material: Chrome-plated, 17-gauge brass tube.
- D. Kitchen/Utility Sinks - Stainless Steel, Freestanding: S-25.
- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Eagle Group product indicated on Drawings or comparable product by one of the following:
    - a. AERO Manufacturing Company.
    - b. Amtekco Industries, Inc; a Wasserstrom Company.
    - c. Advanced Tabco
    - d. Elkay.
    - e. Griffin Products, Inc.
    - f. Just Manufacturing.
  - 2. Source Limitations: Obtain sinks from single source from single manufacturer.
  - 3. Fixture:



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- a. Standards:
  - 1) ASME A112.19.3/CSA B45.4.
  - 2) NSF not required.
- b. Type: Stainless steel, freestanding, unit with backsplash.
- c. Number of Compartments: One.
- d. Overall Dimensions: 25 by 22 inches.
- e. Material: 16 gauge, Type 304 stainless steel.
- f. Compartment:
  - 1) Dimensions: 24 by 18 inches.
  - 2) Drains: Grid with NPS 1-1/2 (DN 40) tailpiece and basket drain.
  - 3) Drain Location: Centered in compartment.
- 4. Legs and Feet: Stainless steel tubing legs with adjustable bullet feet.
- 5. Faucet(s): S-5 sink faucet designation from "Manually Operated Sink Faucets" .
  - a. Number Required: One.
  - b. Mounting: On backsplash.
- 6. Supply Fittings:
  - a. Standard: ASME A112.18.1/CSA B125.1.
  - b. Supplies: Chrome-plated brass quarter turn ball stop with inlet connection matching water-supply piping type and size.
    - 1) Operation: Wheel handle.
    - 2) Risers: NPS 1/2 (DN 15), ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.
- 7. Waste Fittings:
  - a. Standard: ASME A112.18.2/CSA B125.2.
  - b. Trap(s):
    - 1) Size: NPS 1-1/2 (DN 40).
    - 2) Material:
      - a) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

## 2.3 MANUALLY OPERATED SINK FAUCETS

- A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.



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B. Commercial Sink Faucets - Manual Type: Two-handle mixing, S-1.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn product indicated on Drawings or comparable product by one of the following:
  - a. Chicago Faucets; Geberit Company.
  - b. Gerber Plumbing Fixtures LLC.
  - c. Speakman Company.
  - d. T&S Brass and Bronze Works, Inc.
2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Standard: ASME A112.18.1/CSA B125.1.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
5. Body Type: Centerset.
6. Body Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.
7. Finish: Chrome plated.
8. Maximum Flow Rate: 1.0 to 1.28 gpm (3.8 to 4.8 L/min) 1.5 gpm (5.7 L/min).
9. Mounting Type: Deck, exposed.
10. Valve Handle(s): Lever 4-inch (102-mm) wrist blade.
11. Spout Type: Swing.
12. Vacuum Breaker: Not required for hose outlet.
13. Spout Outlet: Laminar flow.

C. Commercial Service Sink Faucets - Manual Type: S-2.

1. Basis-of-Design Product: subject to compliance with requirements, provide Chicago Faucet product indicated on Drawings or comparable product by one of the following:
  - a. Speakman Company.
  - b. T&S Brass and Bronze Works, Inc.
  - c. Zurn Industries, LLC.
2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Description: Wall/back mounted, brass body, with 14-inch swivel spout, inlets 8 inches (200 mm) o.c., and two-handle mixing.
4. Faucet:
  - a. Standards:
    - 1) ASME A112.18.1/CSA B125.1.
    - 2) NSF 61 and NSF 372.
    - 3) ICC A117.1.
    - 4) ASSE 1001 (VB).
  - b. Finish: Polished chrome plated.
  - c. Handles: Lever.
  - d. Cartridges: One-fourth turn compression.



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- e. .
- f. Spout Outlet: Aerator 1.5 gpm

D. Commercial Service Sink Faucets - Manual Type: S-5.

1. Basis-of-Design Product: subject to compliance with requirements, provide Chicago Faucet product indicated on Drawings or comparable product by one of the following:
  - a. Speakman Company.
  - b. T&S Brass and Bronze Works, Inc.
  - c. Zurn Industries, LLC.
2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Description: Wall/back mounted, brass body, with 9-inch swivel spout, inlets 8 inches (200 mm) o.c., and two-handle mixing.
4. Faucet:
  - a. Standards:
    - 1) ASME A112.18.1/CSA B125.1.
    - 2) NSF 61 and NSF 372.
    - 3) ICC A117.1.
    - 4) ASSE 1001 (VB).
  - b. Finish: Polished chrome plated.
  - c. Handles: Lever.
  - d. Cartridges: One-fourth turn compression.
  - e. Spout Outlet: Aerator 1.5 gpm

E. Commercial Service Sink Faucets - Manual Type: MS-1.

1. Basis-of-Design Product: subject to compliance with requirements, provide Chicago Faucets product indicated on Drawings or comparable product by one of the following:
  - a. Speakman Company.
  - b. T&S Brass and Bronze Works, Inc.
  - c. Zurn Industries, LLC.
2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Description: Wall/back mounted, brass body, with integral service stops, pout with bucket/pail hook, 3/4-inch (20-mm) hose thread end, integral vacuum breaker, inlets 8 inches (200 mm) o.c., and two-handle mixing.
4. Faucet:
  - a. Standards:
    - 1) ASME A112.18.1/CSA B125.1.
    - 2) NSF 61 and NSF 372.
    - 3) ICC A117.1.
    - 4) ASSE 1001 (VB).



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- b. Finish: Rough chrome plated.
- c. Handles: Lever.
- d. Cartridges: Ceramic.
- e. Brace: Adjustable top brace.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install sinks level and plumb in accordance with rough-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Set floor-mounted sinks in leveling bed of cement grout.
- D. Install water-supply piping with stop on each supply to each sink faucet.
  - 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping" and Section 22 05 23.15 "Gate Valves for Plumbing Piping."
  - 2. Install stops in locations where they can be easily reached for operation.
- E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- F. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
- G. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."



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3.3 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

3.5 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

**END OF SECTION 22 42 16.16**



## **SECTION 22 47 16 - PRESSURE WATER COOLERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Pressure water coolers.
  - 2. Supports.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of pressure water cooler and bottle filling station.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals:
  - 1. Product Data: For water consumption.
- C. Shop Drawings:
  - 1. Include diagrams for power wiring.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For pressure water coolers and bottle filling stations to include in maintenance manuals.

#### **1.5 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.



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1. Filter Cartridges: Equal to 100 percent of quantity installed for each type and size indicated, but no fewer than 1 of each.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

#### A. Standards:

1. Pressure water coolers and bottle filling stations intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
2. Comply with ASHRAE 34 for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
3. Comply with UL 399.
4. Comply with ASME A112.19.3/CSA B45.4.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Comply with NSF 42 and NSF 53 for water filters for water coolers and bottle filling stations.
7. Comply with ICC A117.1 for accessible water coolers and bottle filling stations.

### 2.2 PRESSURE WATER COOLERS

1. Pressure Water Coolers - Surface Wall-Mounted, Stainless Steel: Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Halsey Taylor.
  - b. Murdock Manufacturing; A Division of Morris Group International.
  - c. Oasis International.
  - d. Haws
2. Source Limitations: Obtain surface wall-mounted, stainless steel, pressure water coolers from single source from single manufacturer.
3. Type: Vandal resistant.
4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
5. Control: Push button.
6. Bottle Filler: Sensor activation, with automatic shutoff timer: Fill rate 0.5 to 1.5 gpm (0.03155 to 0.09464 L/s).
7. Drain: Grid with NPS 1-1/4 (DN 32) tailpiece.
8. Supply: NPS 3/8 (DN 10) with shutoff valve.
9. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 (DN 32) brass P-trap.



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10. Filter: One or more water filters with capacity sized for unit peak flow rate.
11. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
12. Support: Water-cooler carrier.
13. Water-Cooler Mounting Height: High/low - standard/accessible in accordance with ICC A117.1.
14. Capacities and Characteristics:
  - a. Cooled Water: 8 gph (0.0084 L/s).
  - b. Ambient-Air Temperature: 90 deg F (32 deg C).
  - c. Inlet-Water Temperature: 80 deg F (27 deg C).
  - d. Cooled-Water Temperature: 50 deg F (10 deg C).
  - e. Electrical Characteristics:
    - 1) Motor Horsepower: 1/5.
    - 2) Volts: 120 V ac.
    - 3) Phase: Single.
    - 4) Hertz: 60 Hz.

## 2.3 SUPPORTS

### A. Water-Cooler Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Wade Drains.
  - e. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.



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3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping"
- D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.3 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Install ball shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping"
- D. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.



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- C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
  - 2. Nameplates to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.5 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

3.6 CLEANING

- A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

**END OF SECTION 22 47 16**



## **SECTION 23 05 00.1 - COMMON WORK RESULTS FOR HVAC**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements Division 01, Division 23 Specification Sections, and Common Work Requirements for HVAC apply to the work specified in this Section.

#### **1.2 SUMMARY**

- A. This Section includes and applies to all work included in Division 23.
- B. Work in this Section includes providing labor, materials, equipment, services necessary, fabrication, installation and testing for fully operational and safe systems including all necessary materials , appurtenances and features whether specified or shown in the contract documents or not, in conformity with all applicable codes and authorities having jurisdiction for the following:
  - 1. Mechanical work covered by all sections within Division 23 of the specifications, including, but not limited to:
    - a. Heating, ventilating and air conditioning systems and equipment and accessories.
    - b. Motors and controllers, including variable frequency drives.
    - c. Control systems.
    - d. Testing and balancing.
    - e. Cleaning of piping systems.
    - f. Cleaning of ductwork, casings, plenums, etc.
    - g. Dielectric fittings.
    - h. Mechanical sleeve seals.
    - i. Escutcheons.
    - j. Grout.
    - k. Equipment installation requirements common to equipment sections.
    - l. Painting and finishing.
    - m. Concrete bases.
    - n. Supports and anchorages.
- C. Provide cutting and patching, for the Mechanical Work.
- D. Provide piping from plumbing terminations, 10 feet from equipment, for water, gas, compressed air and as indicated.



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- E. Provide drainage from noted equipment to floor drains, roof drains, sink, or funnel drains.
- F. Provide piping connections to equipment, as required, for kitchens, laboratories, laundries, and as indicated.

### 1.3 DEFINITIONS

- A. "Furnish" or "Provide": to supply, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically otherwise noted.
- B. "Install": to erect, mount and connect complete with related accessories.
- C. "Supply": to purchase, procure, acquire and deliver complete with related accessories.
- D. "Work": labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
- E. "Piping": pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
- F. "Wiring": raceway, fittings, wire, boxes and related items.
- G. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- H. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- I. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- J. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings, in chases, in enclosures, in trenches or in crawl spaces.
- K. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- L. "Indicated," "Shown" or "Noted": as indicated, shown or noted on drawings or specifications.
- M. "Similar" or "Equal" of base bid manufacture: in the Engineer's opinion, equal in materials, weight, size, design, and efficiency of specified product, conforming with 2.01 MANUFACTURERS.



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- N. "Reviewed," "Satisfactory," or "Directed": as reviewed, satisfactory, or directed by or to Architect.
- O. "Motor Controllers": manual or magnetic starters (with or without switches), individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.
- P. "Control" or "Actuating Devices": automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

#### 1.4 ABBREVIATIONS

- A. The following are industry abbreviations for plastic materials.

- 1. CPVC: Chlorinated polyvinyl chloride plastic.
- 2. PE: Polyethylene plastic.
- 3. PVC: Polyvinyl chloride plastic.

- B. The following are industry abbreviations for rubber materials:

- 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
- 2. NBR: Acrylonitrile-butadiene rubber.

- C. Following is a list of abbreviations and symbols that are used in the specifications:

Word or Symbol	Abbreviation or Symbol Used in Specifications
φ	phase
air conditioning unit	ACU
alternating current	AC
ampere	amp
brake horsepower (bhp)	BHP
British thermal units	Btu
Celsius	C
cfh	CFH
cubic feet per minute	cfm
cubic feet per second	cfs
degree	°
direct current	DC
emergency power system	EPS
etcetera (etc.)	etc.
Fahrenheit	F
feet	ft.
feet per minute	fpm
gallon	gal.
gallons per minute	gpm



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Word or Symbol	Abbreviation or Symbol Used in Specifications
hertz	Hz
horsepower	hp
inches	in.
kilovolt	kV
kilowatt	kW
KVA	kVA
length	length
manufacturer	Mfr.
minute	minute
number	No.
ounce	oz.
percent	%
plus and minus	±
pound or pounds	lb. or lbs.
pounds per square inch (psi)	psi
power factor	pf
psig	psig
PVC	PVC
revolutions per minute (rpm)	rpm
square foot or square feet	sq. ft.
times	times (unless used in an equation, then use x)
uninterruptible power supply (UPS)	UPS
Variable Frequency Drive	VFD
volt	V
water gauge	w.g.
width	width
wire-gauge	awg
WWP	WWP

1.5 UTILITY CONNECTIONS

- A. Arrange for and pay utility costs for work of this Division.
- B. Included:
  - 1. Connection to utility company mains.
  - 2. Connection to on-site piping mains.
  - 3. Payment of service charges.
  - 4. Provisions for temporary utilities.
  - 5. (Others as required.)



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1.6 JOB CONDITIONS

- A. Examine all drawings and specifications in a manner to be fully cognizant of all work required under this Division.
- B. Adjoining work of other Divisions shall be examined for interferences and conditions affecting this Division.
- C. Examine site related work and surfaces before starting work of any Section.
  - 1. Report to Architect, in writing, conditions which will prevent proper provision of this work.
  - 2. Beginning work of any Section without reporting unsuitable conditions to Architect constitutes acceptance of conditions by Contractor.
  - 3. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to Owner.
- D. Special Traffic Requirements:
  - 1. Maintain emergency and service entrances useable to pedestrian, truck, and ambulance traffic at all times.
  - 2. Where trenches are cut, provide adequate bridging for above mentioned traffic.
  - 3. (Other paragraphs as required).

1.7 CLEARANCE FROM ELECTRICAL EQUIPMENT

- A. Piping or ductwork:
  - 1. Prohibited in:
    - a. Electric rooms and closets.
    - b. Telephone rooms and closets.
    - c. Elevator machine rooms.
    - d. Electric switchboard room.
  - 2. Prohibited above an area within 5 ft. of:
    - a. Transformers.
    - b. Motor control centers.
    - c. Standby power plant.
    - d. Bus ducts.

1.8 SUBMITTALS

- A. Submit the following items as hereinafter specified:
  - 1. Names and qualifications of test and balance agencies.



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2. Layout Drawings.
  3. Coordinated Drawings.
  4. As-built Record Drawings (Submitted to Client).
  5. Record Files (Submitted to Client).
  6. Operating and Maintenance Manuals.
  7. Welding certificates.
  8. Equipment and material submittals as required by sections within this division.
- B. Items shall comply with the requirements as hereinafter specified.
- C. Submit shop drawings, product data, samples and certificates of compliance required by contract documents.
1. See Division 1, Submittals for reference of minimum requirements, if not stated hereinbelow.
- D. Schedule of submittals, as agreed to by the Engineer, will set the basis of the minimum required submittals. Submittals shall be provided by the Contractor promptly and in accordance with the Schedule of submittals and in such sequence as to cause no delay in work or in work of any other divisions.
- E. Resubmission Requirements:
1. In addition to Division 1 requirements, make any corrections or change in Submittals required. Resubmit for review until no exceptions are taken or a resubmission is not required.
  2. Shop Drawings and Product Data:
    - a. Revise initial drawings or data, and resubmit as specified for initial submittal.
    - b. Indicate any changes which have been made other than those requested.
  3. Samples: Submit new samples as required for initial submittal.
  4. Clearly identify resubmittal by original submittal date, number and revision number and indicate all changes from previous submittal.
  5. If more than two submissions are required (initial submittal and one resubmittal) based on rejection or lack of compliance by submittal, then the Contractor shall:
    - a. Arrange for additional reviews by the Design Engineers.
    - b. Pay all costs for such additional reviews.
- F. Corrections or comments made on the shop drawings during review do not relieve the Contractor from compliance with requirements of the drawings and specifications. Shop drawing checking by the Engineer is only for review of general conformance with the design concept of the project and general compliance with the information given in the contract documents. The Contractor is responsible for:
1. Confirming and correlating all quantities and dimensions.
  2. Selecting fabrication processes and techniques of construction.



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3. Coordinating his work with that of all other trades.
4. Performing his work in a safe and satisfactory manner.

G. Substitutions:

1. See Division 1, Substitutions.
2. The bid shall include products per paragraph 2.01 MANUFACTURERS. Engineer will consider formal requests for substitution of products in place of those specified only if these are submitted with the bid for evaluation and in accordance with all conditions specified hereafter.
3. Requests for substitutions after award of contract shall be considered only in case of product unavailability. Product unavailability shall be verified in writing by manufacturer.
4. Submit separate request for each substitution at time of bid, or at appropriate time thereafter in the event of non-availability of item included in bid. Support each request with:
  - a. Complete data substantiating compliance of proposed substitution with requirements stated in Contract documents.
  - b. Data relating to changes in construction schedule.
  - c. Any effect of substitution on other Work in this and other Divisions, and any other related contracts, and changes required in other work or products.
5. Contractor shall be responsible at no extra cost to Owner for any changes resulting from proposed substitutions which affect work of other Sections or Divisions, or related contracts.
6. Claims for additional costs caused by substitution which may subsequently become apparent shall be met by the Contractor.
7. Substitutions will not be considered for acceptance when acceptance will require revision of Contract Documents, unless Contractor bears cost of redesign.
8. Where any redesign of electrical, mechanical or other work is required due to substitution, arrangement or equipment layout other than herein specified or shown:
  - a. Arrange for required redesign by Engineer.
  - b. Pay all costs for such redesign.
  - c. Contractor shall perform such redesign.
  - d. Produce detailed plans at no extra cost to Owner.
  - e. All subject to Architect's approval.
9. Substitute products shall not be ordered or installed without prior written approval/acceptance by Architect.
10. Engineer will have sole discretion to determine acceptability of proposed substitutions and reserves the right to reject any such substitution.
11. Approval of substitutions shall not relieve Contractor from full compliance with requirements of Contract documents.

COORDINATE WITH DIVISION 01, SUBMITTAL PROCEDURES AND SUBSTITUTIONS.



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- a. GENERAL CONTRACTOR SHALL REQUEST INDIVIDUAL LAYOUT DRAWINGS FROM MECHANICAL AND ELECTRICAL TRADES, PER SECTION 23 05 00, PARAGRAPH 1.8, AND SECTION 26 05 00, PARAGRAPH 1.05.
- b. CONTRACTOR SHALL ASSURE THAT EACH MECHANICAL AND ELECTRICAL TRADE HAS COORDINATED WORK WITH OTHER TRADES. STAMP EACH LAYOUT SUBMITTAL AND SIGN TO CERTIFY THAT THESE LAYOUTS HAVE BEEN COORDINATED.

H. Layout (Shop) Drawings:

- 1. Submit Layout Drawings indicating work within mechanical rooms areas containing boilers, chillers, cooling towers, air handlers or pumps, areas containing acoustically lined ductwork, food service areas and for any areas. See Division 1 specification sections for additional requirements on layout drawings.
- 2. Layout Drawings for mechanical rooms shall be at a scale of 3/8"=1'-0".
- 3. Prepare layout shop drawings for all areas.
- 4. From the layout drawings, prepare and submit Coordinated Drawings as herein specified below.

I. Coordinated Drawings:

- 1. This Contractor shall prepare coordinated drawings which shall show work of all trades including, but not limited to:
  - a. Items noted in the Supplemental General conditions.
  - b. Coordinated Ductwork with penetrations at floors, walls, ceiling and roof.
  - c. Piping, including:
    - 1) HVAC, plumbing and fire protection.
    - 2) Minor Piping such as drains, air vents, condensate piping, etc.
    - 3) Sleeves and penetrations.
    - 4) Expansion devices, anchors, guides and hangers.
  - d. Mechanical Equipment.
  - e. Supports and suspension devices.
  - f. Ductwork/Piping high points and low points.
  - g. Electrical Equipment.
  - h. Main Electrical conduits and bus ducts.
  - i. Equipment support and suspension devices including hangers, supports and bracing.
  - j. Structural and architectural constraints including:
    - 1) Beams, braces, trusses, flanges, constraints, walls, openings ratings, doors, wall types, glazing.
  - k. Show location of:
    - 1) Valves.
    - 2) Chemical Treatment.



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- 3) Piping specialties.
  - 4) Dampers.
  - 5) Access doors.
  - 6) Control and electrical panels.
  - 7) Disconnect switches
  - 8) Others as required.
2. Drawings shall indicate coordination with work in other Divisions which must be incorporated in mechanical spaces, including, but not limited to:
    - a. Swimming pool equipment and piping.
    - b. Irrigation equipment and piping.
    - c. Elevator equipment.
    - d. Building vacuum cleaning systems.
    - e. Pneumatic tube system.
    - f. Cable trays not furnished under Division 26.
    - g. Computer equipment.
    - h. (Others as required).
  3. Provide sections and elevations for all mechanical rooms, mechanical areas, areas with routed duct mains, areas with routed piping mains, and areas adjacent to the existing structure.
  4. Preparation of drawings:
    - a. Prepare reproducible CADD drawings.
    - b. Submit to other trades for review of space allocated to all trades.
    - c. Revise drawings to compensate for requirements of existing conditions and conditions created by other trades.
  5. Final prepared drawings shall show that other trades affected have made reviews and signed, by each trade, at completion of coordination.
  6. Coordinated shop drawings shall be for all areas.
  7. Contractor is to assure that each trade has coordinated work with other trades, prior to submittal.
- J. As-built (Record) Drawings:
1. Provide after installation is complete. Final signoff and Owner acceptance will not occur prior to submission of As-built drawings to Owner.
  2. Indicate as-built conditions and all revisions that occurred subsequent to "Coordinated Drawings" submittal, fully illustrating all revisions made by all trades in the course of work.
  3. Dimension physical locations of ductwork, and piping with reference elevations and distances above finished floors, below beams, from wall faces, underground (invert elevations) and from column lines.
  4. Exact location, type and function of concealed valves, dampers, controllers, piping, air vents, piping drains and isolators.
  5. Indicate all equipment sizes and capacities and tag numbers.
  6. Provide drawing on reproducible CADD mylar.



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7. These drawings shall be for as-built record purposes for the Owner's use and are not considered shop drawings.

K. Record Files:

1. Provide 5 (five) electronic file copies of the As-built CADD drawings in the media (CDROM, Disks, Tape, etc.) of Owner's choice.
2. Include hard copy and electronic copy of file naming convention, layering standards, drawing index and file descriptions.
3. Electronic files shall be modifiable and shall include all associated referenced background files.

L. Operating Instructions, Maintenance Manuals and Parts Lists:

1. Before requesting acceptance of work, submit one set for review by Architect.
2. After review, furnish five printed and bound sets.
3. Include:
  - a. Manufacturer's name, model number, service manual, spare-parts list, and descriptive literature for all components, cross referenced and numbered on Record Drawings as required.
  - b. Maintenance instructions.
  - c. Listing of possible breakdown and repairs.
  - d. Instruction for starting, operation and programming.
  - e. Detailed and simplified one line, color coded flow and wiring diagram.
  - f. Field test report, including:
    - 1) Instrument set points.
    - 2) Normal operating valves.
  - g. Name, address and phone number of contractors equipment suppliers and service agencies.
  - h. Assemble manufacturer's equipment manuals in chronological order, following the specification alpha-numeric system, in heavy duty 3-ring binders clearly titled on the spine and front cover with appropriate index dividers.

M. Quantity of Submittals Required.

1. Layout (Shop) Drawings and Coordinated Drawings:
  - a. Submit two prints and an **electronic copy**.
  - b. Copies of these prints and an **electronic copy** will serve as record copies for Architect.
2. Product Data (brochures):
  - a. Submit two copies of product data and an **electronic copy**.
  - b. Upon review, an **electronic copy** will be returned.



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- c. If comments are required, they will be returned with each copy.
- d. One copy will be retained by the Engineer.

#### 1.9 RELATED WORK AND REQUIREMENTS

- A. Requirements of General Conditions and Division No.1 apply to all work in this division.
- B. Carefully check the documents of each section with those of other sections and Divisions. Ascertain the requirements of any interfacing materials or equipment being furnished and/or installed by those sections and Divisions, and provide the proper installation and/or required interface.
- C. As a minimum requirement and condition, the Contractor shall provide CADD generated drawings (for the purpose of Layout Drawings, Coordinated Drawings, As-built Drawings and Record Drawings) with a proven layering standard. Deviation from this requirement shall be:
  - 1. At the sole discretion of the Engineer.
  - 2. Submitted as a substitution within the specified time frame.
- D. Related work specified elsewhere:
  - 1. Providing temporary heat.
  - 2. Providing finish painting, including pipe stenciling.
  - 3. Access doors.
  - 4. Trench covers and frames.
  - 5. Providing chimney cleanout door and thimble.
  - 6. Cutting and patching, except as noted in "AIA Document A201" and "Supplementary Conditions for Mechanical and Electrical Work.
  - 7. Excavating and backfilling under building.
  - 8. Excavating and backfilling.
  - 9. Louvers in doors.
  - 10. Undercut doors.
  - 11. Wall louvers and screens.
  - 12. Plenums other than sheet metal.
  - 13. Flashing.
  - 14. Shaft gratings.
  - 15. Equipment platforms.
  - 16. Pipe heat tracing system.

#### 1.10 QUALITY ASSURANCE

- A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.
- B. Supply all equipment and accessories new and free from defects.



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- C. Supply all equipment and accessories in compliance with the applicable standards and with all applicable national, state and local codes.
- D. All items of a given type shall be the products of the same manufacturer.
- E. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- F. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.11 REFERENCE STANDARDS

- A. Published codes, specifications, standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this Division where cited below:
  - 1. AABC: Associated Air Balance Council.
  - 2. ADC: Air Diffuser Council.
  - 3. AMCA: Air Moving and Conditioning Association.
  - 4. ANSI: American National Standards Institute.
  - 5. ARI: Air-Conditioning and Refrigeration Institute.
  - 6. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.
  - 7. ASME: American Society of Mechanical Engineers.
  - 8. ASSE: American Society of Sanitary Engineers.
  - 9. ASTM: American Society for Testing and Materials.
  - 10. AWS: American Welding Standards.
  - 11. FM: Factory Mutual.
  - 12. Local Utility Authorities.
  - 13. National, State and Local Codes of all authorities having jurisdiction.
  - 14. NEMA: National Electrical Manufacturer's Association.
  - 15. NFPA: National Fire Protection Association.
  - 16. OSHA: Occupational Safety and Health Act.
  - 17. PDI: Plumbing and Drainage Institute.
  - 18. State Energy Code having jurisdiction
  - 19. UBC: Uniform Building Code.
  - 20. UL: Underwriters' Laboratories, Inc.
  - 21. UMC: Uniform Mechanical Code.
  - 22. UPC: Uniform Plumbing Code.
- B. In addition to complying with all other legal requirements, comply with current provisions of governing codes and regulations in effect during progress of the Work, and with the following:



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1. Drawings and specification requirements shall govern where they exceed Code and Regulation requirements.
2. Where requirements between governing Codes and Regulations vary, the more restrictive provisions shall apply.
3. Nothing contained in Contract Documents shall be construed as authority or permission to disregard or violate legal requirements. The Contractor shall immediately draw the attention of the Architect to any such conflicts noted in the Contract Documents.

1.12 DESCRIPTION OF BID DOCUMENTS

A. Specifications:

1. Specifications, in general, describe quality and character of materials and equipment.
2. Specifications are of simplified form and include incomplete sentences.
3. Words or phrases such as "The Contractor shall," "shall be," "furnish," provide," "a," "an," "the," and "all" etc. have been omitted for brevity.

B. Drawings:

1. Drawings in general are diagrammatic and indicate scope, sizes, routing, locations, connections to equipment and methods of installation, but not necessarily offsets, obstructions or structural conditions. Locations on drawings may be distorted for purposes of clearness and legibility.
2. Contractor to provide additional offsets, fittings, hangers, supports, valves, drains as required for construction and coordination with work of other trades.
3. Scaled and figured dimensions are approximate and are for estimating purposes only, but shall be followed with sufficient accuracy to coordinate with other work and structural limitations.
4. Before proceeding with work, check and verify all dimensions and carefully check space requirements with other Work to ensure that all equipment and materials can be installed in spaces allotted.
5. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
6. The Contractor is responsible for installing the work in such a manner that it will conform to the structure and architectural elements, avoid obstructions, maintain headroom, leave adequate clearance for proper maintenance and repairs, and provide clearances and access required by codes.
7. Make adjustments that may be necessary or requested in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
8. Above items to be performed at no additional cost to the Owner.

- C. If any part of Specifications or Drawings appears unclear or contradictory, consult with Architect and/or Engineer for interpretation and decision as early as possible during bidding period. Do not proceed with such work without Architect's and or Engineer's decision.



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- D. Typical details, where shown on the drawings, apply to each and every item of the project where such items are applicable. Typical details are not repeated in full on the plans, and are diagrammatic only, but with the intention that such details shall be incorporated in full.

1.13 TEMPORARY FACILITIES

- A. See division 1 for temporary facilities required.
1. Temporary water supply for construction per Specifications for Plumbing Work..
  2. Temporary toilet facilities:
    - a. Provide, where directed by Architect, temporary toilet facilities for use of all workman on project.
    - b. Conform to requirements of all authorities having jurisdiction.
    - c. Connect water to temporary water lines and drainage to sewer.
    - d. Temporary toilets will be maintained by General Contractor who will pay for water consumed.
    - e. At completion of job, or when directed by Architect, remove temporary toilet facilities and piping.

1.14 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces.

1.15 SPECIAL TOOLS

- A. Furnish to Owner at completion of work:
1. One set of any special tools required to operate, adjust, dismantle or repair equipment furnished under any section of this Division.
  2. "Special tools": those not normally found in possession of mechanics or maintenance personnel.
  3. One pressure grease gun for each type of grease required.
    - a. With adapters to fit all lubricating fittings on equipment.
    - b. Include lubricant for lubricated plug valves.
  4. Tag each item and cross reference in Maintenance Manual.



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5. Turn over to Owner's representative or temporarily secure to unit at Architect's instruction.

1.16 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- C. Check dimensions of access route through the site from delivery point to final location. Where necessary, ship in crated sections of size to permit passing through available space. Dismantle and/or reassemble, reprovision and retest equipment too large to pass through available access route to final location in one piece.
- D. Ship equipment in original packages, to prevent damaging or entrance of foreign matter.
- E. Handle and ship in accordance with manufacturer's recommendations.
- F. Provide protective coverings during construction.
- G. Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by Architect.
- H. Tag all items with weatherproof tag, identifying equipment by name and purchase order number.
- I. Include packing and shipping lists.
- J. Special requirements as specified in individual sections.

1.17 PROTECTION OF MATERIALS

- A. Protect from damage, water, dust, etc., material, equipment and apparatus provided under this Division, both in storage and installed, until Notice of Completion has been filed.
- B. Provide temporary storage facilities for material and equipment.
- C. Arrange with Owner for storage facilities for materials and equipment.
- D. Material, equipment or apparatus damaged because of improper storage or protection will be rejected.



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1. Remove from site and provide new, duplicate, material equipment or apparatus in replacement of that rejected.
- E. Cover motors and other moving machinery to protect from dirt and water during construction.
- F. Protect premises and work of other Divisions from damage arising out of installation of work of this Division.
  1. Repair or replace, as directed by Architect, materials and parts of premises which become damaged as result of installation of work of this Division.
  2. Remove replaced parts from premises.

1.18 REVIEW OF CONSTRUCTION

- A. Work may be reviewed at any time by representatives of Architect.
- B. Advise Architect in writing that work is ready for review at following times:
  1. Prior to backfilling buried work.
  2. Prior to concealment of work in walls and above ceilings.
  3. When all requirements of Contract have been completed.
- C. Neither backfill nor conceal work without Architect's consent.

1.19 SCHEDULE OF WORK

- A. Arrange work to conform to schedule of construction established or required to comply with Contract Documents.
- B. In scheduling, anticipate means of installing equipment through available openings in structure.
- C. Confirm in writing to Architect, within 30 days of signing of contract, anticipated number of days required to perform test, balance, and acceptance testing of mechanical systems:
  1. This phase must occur after completion of mechanical systems, including all control calibration and adjustment, and requires substantial completion of the building, including closure, ceilings, lighting, partitioning, etc.
  2. Submit for approval at this time, names and qualifications of test and balancing agencies to be used.
- D. Arrange with Owner schedule for work in each area.
- E. Unless otherwise directed by Owner perform work during normal working hours.



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F. Work delays:

1. In case noisy work interferes with Owner's operations, Owner may require work to be stopped and performed at some other time, or after normal working hours.
2. Submit, with bid proposal, schedule of hourly rates and overtime premiums.

1.20 NOISE REDUCTION

- A. Cooperate in reducing objectionable noise or vibration caused by mechanical systems.
1. To extent of adjustments to specified and installed equipment and appurtenances.
- B. Correct noise problems caused by failure to install work in accordance with Contract Documents. Include labor and materials required as result of such failure.

1.21 PERMITS, LICENSES, AND INSPECTIONS

- A. Permits and Licenses:
1. Secure required permits and licenses including payments of all charges and fees.
- B. Inspections:
1. Obtain certificates of final inspection approval from authorities having jurisdiction, and submit to Architect before acceptance of the Work.
  2. Obtain inspections during the Work as required to allow timely progress of these and other trades.

1.22 GUARANTEE

- A. Guarantee all materials, equipment, apparatus and workmanship to be free of defective materials and faulty workmanship for period of one year from date of filing of Notice of Completion, unless extended guarantee periods are specified in individual sections.
- B. Furnish guarantee covering all work in accordance with general requirements of the Contract.
- C. Provide new materials, equipment, apparatus and labor to replace that determined by Architect to be defective or faulty.
- D. This guarantee also applies to services such as Instructions, Adjusting, Testing, Noise, Balancing, etc.
- E. Equipment manufacturers shall include extended warranty to give full coverage during warranty period, unless longer period is specified.



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1.23 PRELIMINARY OPERATION

- A. Any portion of the system or equipment shall be placed in operation at the request of the Owner prior to the final completion and acceptance of the work. Such operation shall be under the direct supervision of the Contractor.
- B. Preliminary operation thereof shall not be construed as acceptance of any part of the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Division 23 Sections where articles and subparagraphs introduce lists, the following requirements apply for product selection:
  - 1. Contractor's Options:
    - a. For products specified only by reference standard, select product meeting that standard, by any manufacturer.
    - b. For products specified by naming several products or manufacturers, select any one of products and manufacturers named which complies with Specifications.
    - c. For products specified by naming one product or manufacturer, use that product or manufacturer only.
    - d. Wherever catalog numbers and specific brands or trade names are used, they are used to establish standards of quality, utility and appearance required.
- B. Submission of equipment of manufacturers' other than those specified shall detail equality and difference, item by item.

2.2 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

2.3 ACCESS DOORS

- A. Size for proper access, adjusting and maintenance:



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1. 12 in. x 12 in. minimum for valves, trap primers, shock absorbers, etc.
  2. 24 in. x 24 in. for man access to concealed fans, coils, etc., unless indicated otherwise.
- B. Furnished under Division 8.
- C. Furnish as required by work in this Division.
1. Access door types as appropriate for receiving surface in accordance with Access Doors Section, Division 8.
- D. Supply as required by work in this Division.
- E. Turn over for setting under trade installing surface on which panels are installed. Direct location and setting, after review by architect.
- F. Manufacturers:
1. Access doors:
    - a. Karp Associates, Inc.
    - b. Higgins Mfg. Co.
    - c. Inryco, Inc.: Milcor.
    - d. Walsh-Spencer Co.
- G. Locate and set after review.
- H. Doors, except as noted, flush type with:
1. No. 13 USSG steel door and trim.
  2. No. 16 USSG steel frame.
  3. Metal wings for keying into construction.
  4. Concealed hinges.
  5. Stainless steel cam lock, screwdriver operated.
  6. Similar to Karp Type DSC-214.
  7. Where door cannot swing open:
    - a. Lift off type.
    - b. With safety wire or chain.
    - c. Similar to Karp Type DSC-212.
- I. Doors, in acoustic tile ceilings:
1. No. 13 USSG steel frame.
  2. No. 16 USSG steel pan-type door suitable for receiving tile thickness.
  3. Factory white finish.
  4. Stainless steel cam locks:
    - a. Screwdriver operated.



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- b. Finish flush with tile.
  - c. Minimum 2 per door.
- 5. Hinges: not visible when door is closed.
- 6. Tile filler: under General construction Work.
- 7. Similar to Karp Type DSC-210.
- J. Doors recessed in plaster ceilings:
  - 1. With recess to receive plaster.
  - 2. Plaster fill: under General Construction Work.
  - 3. Similar to Karp DSC-210-PL.
- K. Doors in fire-rated construction:
  - 1. Insulated door panel and frame.
    - a. Frame: 16 gauge steel.
    - b. Panel: 20 gauge steel.
    - c. 2 in. thick fire rated insulation.
  - 2. Conform to requirements of regulating agencies.
  - 3. Rating: UL 1 1/2 hour "B" label, 250°F rating.
  - 4. Continuous hinge with stainless steel pin.
  - 5. Automatic panel closer.
  - 6. Interior latch release.
  - 7. Finish:
    - a. Stainless steel.
    - b. With stainless steel trim for frame.
    - c. No. 4 satin finish.
  - 8. Lock:
    - a. Self-latching.
    - b. Direct action knurled knob.
    - c. Flush screwdriver operated.
    - d. Key-operated cylinder lock with two keys.
    - e. Knurled knob and mortise cylinder. Cylinder replaceable with cylinder for master keying system.
    - f. Similar to Karp Type KRP-150 FR.
- L. Doors: Shop-painted 1 coat zinc chromate primer.

## 2.4 ACCESS TILE IDENTIFICATION

- A. Buttons, tabs, and markers: to identify location of concealed work.
- B. Submit for review.



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2.5 MISCELLANEOUS METAL WORK

A. Access Platforms:

1. Under General Construction Work.
2. Provide removable gratings, toeplates and guard rails: suitable for minimum 100 lb per sq.ft. floor loading.
3. Supports:
  - a. Welded structural steel.
  - b. Cross-braced on 4 sides.
  - c. Welded to baseplates for anchor bolting to concrete piers.
4. Provide access platforms for equipment, where indicated or required by authorities having jurisdiction. Submit shop drawings with details of construction and method of attachment.
5. In accordance with OSHA regulations.
6. Grating similar to:
  - a. Steel: Irving "X-Bar".
  - b. Aluminum: Irving "X-Bar".
  - c. Fiberglass: Ryerson Duradek I-5000.

B. Ladders:

1. Under General Construction Work.
2. Under General Construction Work except at Cooling Towers.
  - a. See Section 23 65 00: Cooling Towers,
3. Galvanized structural steel.
4. 18 in. wide.
5. 2 1/2 in. x 1/2 in. side rails.
6. 3/4 in. diameter rungs 12 in. on center.
7. In accordance with OSHA regulations.

C. Gratings in Shafts:

1. Under General Construction Work.
2. Suitable for minimum 100 lb per sq.ft. floor loading.
3. Support on structural steel members.
4. Submit shop drawings with details of construction and method of attachment.
5. Grating similar to:
  - a. Steel: Irving "X-Bar".
  - b. Aluminum: Irving "X-Bar".
  - c. Fiberglass: Ryerson Duradek I-5000.

D. Trench Covers, or Gratings and Frames:



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1. Under General Construction Work.
2. Covers:
  - a. Galvanized checkered steel with:
  - b. Galvanized expanded and perforated steel with:
    - 1) Flush drop-type lift handles.
    - 2) Means for securing to frame for easy removal.
  - c. 3 ft. long.
  - d. 1/4 in. thick.
3. Gratings: steel similar to Irving Grating.
4. Frames: 2 in. x 2 in. x 1/4 in. galvanized welded angle iron with welded stops and lugs for anchoring into concrete.
5. Turn over for setting under General Construction work.

E. Guards and Railings:

1. Furnish guards and railings as indicated and/or as required by Authorities having jurisdiction.
2. Provide OSHA approved guards for belt drives and rotating equipment.
3. Guards removable with:
  - a. Frames: No. 18 USSG steel.
  - b. Fronts: No. 20 USSG galvanized perforated steel with:
    - 1) Covered test openings to permit rpm readings without removal.
  - c. Supports: galvanized steel angles or channels, braced to maintain clearances of moving parts.
  - d. Clearance for motor adjustment.
4. Railings: removable of 1¼ in. pipe and rail fittings.

2.6 PAINTING

A. Manufacturers:

1. Sherwin-Williams.
2. Pittsburgh Plate Glass Co.
3. Pratt and Lambert.
4. Rust-Oleum.

B. Materials:

1. Best grade for its purpose.
2. Deliver in original sealed containers.



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3. Apply in accordance with manufacturers instructions.
4. Heat resistant paint for hot piping, equipment and materials.
5. Colors as selected.

## PART 3 - EXECUTION

### 3.1 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.
- E. Access to Valves and Equipment.
  1. Access shall be possible where valves, expansion joints, fire dampers, motors, filters, control devices, and any other equipment requiring access for servicing, repairs, or maintenance are located in walls, chases, and/or above ceilings.
  2. Definition of Accessible:
    - a. Valves and dampers may be operated.
    - b. Control devices may be adjusted.
    - c. Fire dampers may be reset.
    - d. Equipment access panels may be opened.
    - e. Normal maintenance work such as replacement of filters, lubrication of bearings, etc., may be performed readily within arm's reach of access opening.
    - f. It shall not be necessary to crawl through furred ceiling space to perform such operations.
  3. Group concealed valves, expansion joints, controls, dampers and equipment requiring service access, so as to be freely accessible through access doors and to minimize the number of access doors required.
  4. Relocate piping equipment and accessories as required, at no extra cost to afford proper maintenance access.
  5. For access into ductwork see Section 23 33 00: Air Duct Accessories.
  6. Coordinate location of access panels with applicable trades installing walls or ceiling.
    - a. Coordinate panel locations with lights and other architectural features.



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- b. Submit proposed panel locations to Architect for review.
- 7. Access doors or panels will be installed by the trade furnishing surface on which panels are installed.
- 8. Arrange for location and marking of removable tiles in splined ceilings where access panels are not installed.
- 9. Existing Structures:
  - a. When installation requires access openings through existing construction, provide necessary panels, and arrange for respective trades to provide openings and framing which may be required.
  - b. Restore adjoining existing surfaces to original condition after new access panels have been installed.

### 3.2 PAINTING

- A. Painting of exposed roof-top equipment.
- B. Finish painting under Division 09 Sections "Interior Painting" and "Exterior Painting."
  - 1. Colors coordinated by Mechanical Contractor as directed by Architect.
- C. Painting under this Division:
  - 1. Interior of ductwork as far back as visible from outside: flat black.
  - 2. Uncoated hangers, supports, rods and inserts: dip in zinc chromate primer.
  - 3. Factory prime coat for following except as noted.
    - a. Pumps.
    - b. Fans.
    - c. Motors.
    - d. Equipment.
    - e. Air outlets.
    - f. Converter.
  - 4. Marred surfaces of prime coated equipment and piping: spot prime coat to match adjacent coat.
  - 5. Shop prime coat for following, except as noted:
    - a. Structural frames.
    - b. Platforms.
    - c. Ladders.
    - d. Railings.
    - e. Tanks.
- D. General:
  - 1. Labor, materials and equipment necessary for field painting.



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2. Protect flooring and equipment with drip cloths.
3. Paint and materials stored in location where directed.
4. Oily rags and waste removed from building every night.
5. Furnish each space containing stored painting materials with approved 2½ gallon fire extinguisher.
6. Wire brush and clean off all oil, dirt and grease areas to be painted before paint is applied.
7. Mixing:
  - a. Mixed and strained as required by manufacturer.
  - b. Use thinners only in accordance with manufacturers recommendation.
  - c. Follow printed instructions on paint containers. If none are available, instructions shall be obtained in writing from manufacturer.
8. Workmanship:
  - a. No painting or finishing shall be done with:
    - 1) Dust laden air.
    - 2) Unsuitable weather conditions.
    - 3) Space temperature below 60°F.
  - b. Pipes being painted: containing no heat and to remain cold until paint is dried.
  - c. Paint spread: uniform and proper film thickness showing no runs, sags, crawls or other defects.
  - d. Finished surfaces shall be uniform in sheen, color, and texture.
  - e. All coats to be thoroughly dry before succeeding coats are applied, minimum 24 hrs. between coats.
  - f. Priming undercoat: slightly different color for inspection purposes.
9. Exposed, uninsulated, ungalvanized sheet metal other than stainless steel and aluminum: Two coats of aluminum paint or alkyd paint color as directed.
10. Exposed, uninsulated, galvanized sheet metal in finished space including mechanical equipment rooms:
  - a. One coat galvanized iron primer.
  - b. Two coats alkyd oil paint, color as directed.
11. Exposed, insulated piping and equipment covering:
  - a. One coat primer sealer.
  - b. Two coats alkyd oil paint, color as directed.
12. Finned tube radiation: One coat factory or field applied coat of heat resisting paint.
13. Paint following with two coats alkyd oil paint, color as directed:
  - a. Exposed steel and metal work not furnished with factory-painted finish.



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- b. Structural steel supports for piping ductwork and equipment.
  - c. Exposed, uninsulated piping.
- 14. Exposed, uninsulated aluminum sheet metal in finished space:
  - a. One coat zinc chromate primer.
- 15. No paint on exposed, uninsulated stainless steel sheet metal in finished space.
- E. Finish painting:
  - 1. Consisting of two finished coats of high gloss medium or long alkyd paint over prime coat.
  - 2. Submit color shade for approval.
  - 3. Piping continuously painted in all exposed areas.
  - 4. Color coding per Section 23 05 53: Mechanical Identification for HVAC piping and equipment
- F. Interior of ductwork as far back as visible from outside: flat black.
- G. Uncoated hangers, supports, rods and inserts: dip in zinc chromate primer.
- H. Factory finish:
  - 1. Steel air outlets in acoustical tile ceilings: baked white enamel.
  - 2. Aluminum air outlets: anodized.
  - 3. Exposed fan coil units: baked enamel.
  - 4. Unit ventilators and unit heaters: baked enamel.
- I. Factory prime coat, except as noted:
  - 1. Pumps.
  - 2. Fans.
  - 3. Motors.
  - 4. Equipment.
  - 5. Registers.
  - 6. Diffusers.
  - 7. Grilles.
- J. Marred surfaces of prime coated equipment and piping: spot prime coat to match adjacent coat.
- K. Shop prime coat for following except as noted:
  - 1. Structural frames.
  - 2. Platforms.
  - 3. Ladders.
  - 4. Railings.
  - 5. Tanks.



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3.3 CONCRETE WORK

- A. On concrete floors, install equipment on concrete housekeeping pads:
  - 1. Pads 4 in. high unless otherwise noted.
  - 2. Extend 6 in. minimum beyond equipment base, all sides.
  - 3. Concrete work, including forming and reinforcing, under Division 03
    - a. Coordinate size and location with General Contractor.
    - b. Furnish and locate anchors and anchor bolts.
  - 4. Curbs for field erected plenums similar.
- B. Miscellaneous Concrete Items:
  - 1. Concrete work, including forming and reinforcing, under Division 03 (or insert specific Section number for this project.)
  - 2. Concrete for:
    - a. Anchor and thrust blocks.
    - b. Underground tank hold down slabs.
    - c. Pipe trenches.
  - 3. Refer to details on drawings.
- C. Provide foundations for:
  - 1. Pumps.
  - 2. Fans.
  - 3. Air handling units and floor mounted plenums
  - 4. Refrigeration equipment.
  - 5. Boilers.
  - 6. Air Compressors.
  - 7. Floor mounted tanks
  - 8. Floor mounted control panels.
  - 9. Motors.
  - 10. Heat exchangers.
  - 11. Convertors.
  - 12. As noted.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.



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3.5 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.6 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.7 CUTTING AND PATCHING

- A. All carpentry, cutting and patching to be done under trades doing that work.
- B. Provide all carpentry, cutting and patching required for proper installation of material and equipment specified in this Division.
- C. Do not cut or drill structural members without consent of Architect.
- D. All cutting and repairing shall conform to Title 21 of California Administrative Code.

3.8 CUTTING THROUGH CELLULAR FLOORING

- A. Cut openings for reception of work:
  - 1. In accordance with manufacturer's recommendations and approval.



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2. Not to interrupt continuity of electrical raceways.

### 3.9 WATER PROOFING

- A. Under General Construction Work.
- B. Where any work pierces waterproofing, installation shall be subject to review.
  1. Provide all necessary sleeves, caulking, flashing and flashing fittings required to make openings absolutely watertight.
- C. Flashing:
  1. 6 lb. lead.
  2. 16 oz. lead coated copper.
  3. No.22 USSG aluminum.
  4. Fittings for piping through roof:
    - a. Galvanized cast iron bottom recess roof type.
    - b. Similar to Josam No. 26440 or No. 26450.
- D. Provide weather protection canopies, hoods or enclosures over out-of-door equipment which could be damaged by exposure to weather.
  1. This requirement applies to:
    - a. Damper operators.
    - b. Damper bearings.
    - c. Controls.
    - d. Instruments.
  2. See other sections in this Division for application of this requirement to motors, drives, ducts, and fans, etc.
  3. Identify items under such covers if entirely enclosed.

### 3.10 CLEANING AND ADJUSTING

- A. Brush and clean work prior to concealing, painting and acceptance. Perform in stages if directed.
- B. Painted or exposed work soiled or damaged: clean and repair to match adjoining work before final acceptance.
- C. Remove debris from inside and outside of materials and equipment.
- D. Flush out piping after installation.



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- E. Clean piping systems as described in Division 23, Section Hydronic Piping.
- F. Adjust valves and automatic control devices.
- G. Traps, wastes and supplies: unobstructed.

3.11 FIELD QUALITY CONTROL

- A. Tests:
  - 1. Perform as specified in individual sections, and as required by authorities having jurisdiction.
  - 2. Duration as noted.
- B. Provide required labor, material, equipment, and connections.
- C. Furnish written report and certification that tests have been satisfactorily completed.
- D. Repair or replace defective work, as directed.
- E. Pay for restoring or replacing damaged work due to tests, as directed.
- F. Pay for restoring or replacing damaged work of others, due to tests, as directed.

3.12 TRAINING

- A. Provide training by qualified manufacturers' representatives for equipment as specified in this Division.
- B. Training to include:
  - 1. Site-specific training.
  - 2. Minimum hours as specified in each Section.
  - 3. Training materials (minimum six sets).
  - 4. Videotapes (2 copies) of each training session upon completion.
- C. Each training session to be scheduled with Owner at least 30 days in advance.

**END OF SECTION 23 05 00.1**



## SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Restrained-spring isolators.
3. Housed-restrained-spring isolators.
4. Pipe-riser resilient support.
5. Resilient pipe guides.
6. Restrained-air-spring isolators.
7. Elastomeric hangers.
8. Spring hangers.
9. Snubbers.
10. Restraints - rigid type.
11. Restraints - cable type.
12. Restraint accessories.
13. Post-installed concrete anchors.
14. Concrete inserts.
15. Vibration isolation equipment bases.

#### 1.2 DEFINITIONS

- A. Designated Seismic System: An HVAC component that requires design in accordance with ASCE/SEI 7, Ch. 13, and for which the Component Importance Factor is greater than 1.0.
- B. IBC: International Building Code.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  2. Include load rating for each wind-force-restraint fitting and assembly.
  3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic- and wind-force-restraint component.
  4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as



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evaluated by ICC-ES product listing and agency acceptable to authorities having jurisdiction.

5. Annotate to indicate application of each product submitted and compliance with requirements.
6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittals:

1. For each seismic-restraint and wind-load protection device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint accessory, concrete anchor and insert, and restrained isolation roof-curb that is required by this Section or is indicated on Drawings, submit the following:
  - a. Seismic and Wind-Load Restraint, and Vibration Isolation Base Selection: Select vibration isolators, seismic and wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
  - b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
  - c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
  - d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
  - e. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
  - f. Qualified Professional Engineer: All designated-design submittals for seismic- and wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
2. Seismic- and Wind- Restraint Detail Drawing:
  - a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.



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- b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
  - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
- 3. All delegated design submittals for seismic- and wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
  - 4. Product Listing, Preapproval, and Evaluation Documentation: By an evaluation service member of ICC-ES and agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and basis for approval (tests or calculations).
  - 5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
  - 6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Air-Spring Isolator Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.
- E. Field quality-control reports.
- F. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.
  - 1. Provide equipment manufacturer's written certification for each designated active mechanical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270 (AHRI 1271), including shake table testing per ICC-



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- ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or experience data as permitted by ASCE/SEI 7-05 ASCE/SEI 7-10 ASCE/SEI 7-16.
2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-05 ASCE/SEI 7-10 ASCE/SEI 7-16.
  3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.
- G. Wind-Force Performance Certification: Provide special certification for HVAC components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.
1. Provide equipment manufacturer's written certification for each designated HVAC device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
  2. Provide manufacturer's written certification for each designated louver, damper, or similar device, stating that it will remain in place and protect opening from penetration of windborne debris and comply with all requirements of authorities having jurisdiction.
  3. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
- 1.5 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For restrained-air-spring isolators to include in operation and maintenance manuals.
- 1.6 QUALITY ASSURANCE
- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic- and Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing an agency acceptable to authorities having jurisdiction.



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PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design seismic and wind-load control system.
1. Seismic and Wind-Load Performance: Equipment to withstand the effects of earthquake motions and high wind events determined in accordance with ASCE/SEI 7-05 ASCE/SEI 7-10 ASCE/SEI 7-16.
- B. Seismic Design Calculations:
1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05 ASCE/SEI 7-10 including supplement No. 1 ASCE/SEI 7-16 Insert ASCE/SEI 7 edition or other seismic calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the Section Text.
- a. Data indicated below to be determined by Delegated Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
- b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
- c. Building Occupancy Category: III.
- d. Building Risk Category: III.
- e. Building Site Classification: E.
2. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.
- a. Horizontal Seismic Design Force  $F_p$ : Value is to be calculated by Delegated Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation:
- 1)  $S_{DS}$  = Spectral Acceleration: 0.612g. Value applies to all components on Project.
- 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.
- 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
- 4)  $W_p$  = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from each component submittal.



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- 5)  $R_p$  = Component Response Modification Factor: See Drawing Schedule for each component.
  - 6)  $z$  = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated Design Contractor. For items at or below the base, " $z$ " to be taken as zero.
  - 7)  $h$  = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated Design Contractor.
- b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
- c. Seismic Relative Displacement  $D_{pi}$ : Calculate by Delegated Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:
- 1)  $D_p$  = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.
  - 2)  $I_e$  = Structure Importance Factor: Value applies to all components on Project.
  - 3)  $\delta_{xA}$  = Deflection at Building Level  $x$  of Structure A: See Drawing Schedule for each component.
  - 4)  $\delta_{yA}$  = Deflection at Building Level  $y$  of Structure A: see Drawing Schedule for each component.
  - 5)  $\delta_{yB}$  = Deflection at Building Level  $y$  of Structure B: See Drawing Schedule for each component.
  - 6)  $h_x$  = Height of Level  $x$  to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
  - 7)  $h_y$  = Height of Level  $y$  to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
  - 8)  $\Delta_{aA}$  = Allowable Story Drift for Structure A: See Drawing Schedules for each component.
  - 9)  $\Delta_{aB}$  = Allowable Story Drift for Structure B: See Drawing Schedules for each component.
  - 10)  $h_{sx}$  = Story Height Used in the Definition of Allowable Drift  $\Delta_a$ : See Drawings Schedules for each component.
- d. Component Fundamental Period  $T_p$ : Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:
- 1)  $W_p$  = Component Operating Weight: Determined by Contractor from Project Drawings and manufacturer's data.
  - 2)  $g$  = Gravitational Acceleration:  $32.17 \text{ fps}^2$  ( $9.81 \text{ m/s}^2$ ).
  - 3)  $K_p$  = Combined Stiffness of Component, Supports, and Attachments: Determined by delegated design seismic engineer.



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3. Calculation Factors, ASCE/SEI 7-10, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-10 unless otherwise noted.
- a. Horizontal Seismic Design Force  $F_p$ : Calculated by Delegated Design Contractor by ASCE/SEI 7-10, Equation 13.3-1. Factors below must be obtained for this calculation:
- 1)  $S_{DS}$  = Spectral Acceleration: Value applies to all components on Project.
  - 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.
  - 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
  - 4)  $W_p$  = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from equipment submittal.
  - 5)  $R_p$  = Component Response Modification Factor: See Drawing Schedule for each component.
  - 6)  $z$  = Height in Structure of Point of Attachment of Component for Base: Determined from Project Drawings for each component by Contractor. For items at or below the base, "z" to be taken as zero.
  - 7)  $h$  = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated Design Contractor.
- b. Vertical Seismic Design Force: Calculate by Delegated Design Contractor using method explained in ASCE/SEI 7-10, Paragraph 13.3.1.
- c. Seismic Relative Displacement  $D_{pi}$ : Calculate by Delegated Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:
- 1)  $D_p$  = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.
  - 2)  $I_e$  = Structure Importance Factor: 1.25. Value applies to all components on Project.
  - 3)  $\delta_{xA}$  = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
  - 4)  $\delta_{yA}$  = Deflection at Building Level y of Structure A: see Drawing Schedule for each component.
  - 5)  $\delta_{yB}$  = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
  - 6)  $h_x$  = Height of Level x to which Upper Connection point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data;
  - 7)  $h_y$  = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
  - 8)  $\Delta_{aA}$  = Allowable Story Drift for Structure A: See Drawing Schedule for each component.



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- 9)  $\Delta_{aB}$  = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
  - 10)  $h_{sx}$  = Story Height Used in the Definition of Allowable Drift  $\Delta_a$ : See Drawing Schedule for each component.
4. Calculation Factors, ASCE/SEI 7-05, Ch. 3 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-05 unless otherwise noted.
- a. Horizontal Seismic Design Force  $F_p$ : Calculated by Delegated Design Contractor by ASCE/SEI 7-05, Equation 13.3-1. Factors below must be obtained for this calculation:
    - 1)  $S_{DS}$  = Spectral Acceleration: Value applies to all components on Project.
    - 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.
    - 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
    - 4)  $W_p$  = Component Operating Weight: Obtain by Delegated Design Contractor for each component from component submittal.
    - 5)  $R_p$  = Component Response Modification Factor: See Drawing Schedule for each component.
    - 6)  $z$  = Height in Structure of Point of Attachment of Component for Base: Determine by Delegated Design Contractor for each component from Project Drawings. For items at or below the base, "z" to be taken as zero.
    - 7)  $h$  = Average Roof Height of Structure for Base: Determine by Delegated Design Contractor from Project Drawings.
  - b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-05, Paragraph 13.3.1.
  - c. Seismic Relative Displacement  $D_p$ : Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-05, Paragraph 13.3.2. Factors below must be obtained for this calculation:
    - 1)  $\delta_{xA}$  = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
    - 2)  $\delta_{yA}$  = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
    - 3)  $\delta_{yB}$  = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
    - 4)  $h_x$  = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
    - 5)  $h_y$  = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
    - 6)  $\Delta_{aA}$  = Allowable Story Drift for Structure A: See Drawing Schedule for each component.



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- 7)  $\Delta_{aB}$  = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
- 8)  $h_{sx}$  = Story Height Used in the Definition of Allowable Drift  $\Delta_a$ : See Drawing Schedule for each component.

C. Wind-Load Design Calculations:

1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05 ASCE/SEI 7-10 ASCE/SEI 7-16 Insert ASCE/SEI 7 edition or other wind-force calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
  - a. Data indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
  - b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
2. Design wind pressure "p" for external sidewall-mounted equipment such as louvers is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as applicable:
  - a. PART 1: Low-Rise Buildings.
  - b. PART 2: Low-Rise Buildings (Simplified).
  - c. PART 3: Buildings with "h" less than 60 feet (18.3 m).
  - d. PART 4: Buildings with "h" greater than 60 feet (18.3 m) and less than 160 feet (48.8 m).
  - e. PART 5: Open Buildings.
3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
  - a. Risk Category: III.
  - b.  $h$  = Mean Roof Height
  - c.  $V$  = Basic Wind Speed: **103 MPH.**
  - d.  $K_d$  = Wind Directionality Factor
  - e. Exposure Category: C.
  - f.  $K_{zt}$  = Topographic Factor
  - g.  $K_e$  = Ground Elevation Factor
  - h.  $K_z$  = Velocity Pressure Exposure Coefficient (Evaluated at Height  $z$ )
  - i.  $K_h$  = Velocity Pressure Exposure Coefficient (Evaluated at Height  $h$ )



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- j.  $q_z$  = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
  - k.  $q_h$  = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
  - l.  $G$  = Gust-Effect Factor: 0.85.
  - m. Enclosure Classification: ENCLOSED BUILDING.
  - n.  $GC_{pi}$  = Internal Pressure Coefficient: +/-0.18.
4. Design wind pressure "p" for external sidewall-mounted equipment such as louvers are to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:
- a. PART 1: Low-Rise Buildings.
  - b. PART 2: Low-Rise Buildings (Simplified).
  - c. PART 3: Buildings with "h" greater than 60 feet (18.3 m).
  - d. PART 4: Buildings with "h" less than 160 feet (48.8 m).
  - e. PART 5: Open Buildings.
5. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
- a. Risk Category: **III**
  - b.  $h$  = Mean Roof Height
  - c.  $V$  = Basic Wind Speed
  - d.  $K_d$  = Wind Directionality Factor
  - e. Exposure Category: **C**
  - f.  $K_{zt}$  = Topographic Factor
  - g.  $K_z$  = Velocity Pressure Exposure Coefficient
  - h.  $K_h$  = Velocity Pressure Exposure Coefficient
  - i.  $q_z$  = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 or ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
  - j.  $q_h$  = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 or ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
  - k.  $G$  = Gust-Effect Factor: **0.85**
  - l. Enclosure Classification
  - m.  $GC_{pi}$  = Internal Pressure Coefficient
6. Design wind force "F" for rooftop equipment and external sidewall-mounted equipment such as louvers is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.
- a.  $I$  = Importance Factor
  - b.  $h$  = Mean Roof Height



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- c.  $V$  = Basic Wind Speed
  - d.  $K_d$  = Wind Directionality Factor
  - e. Exposure Category: **C**
  - f.  $K_{zt}$  = Topographic Factor
  - g.  $K_z$  = Velocity Pressure Exposure Coefficient (Evaluated at Height  $z$ )
  - h.  $K_h$  = Velocity Pressure Exposure Coefficient (Evaluated at Height  $h$ )
  - i.  $q_z$  = Velocity Pressure at Height  $z$ : Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
  - j.  $q_h$  = Velocity Pressure at Roof Height  $h$ : Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
  - k.  $G$  = Gust-Effect Factor: **0.85**
  - l.  $GC_{pi}$  = Internal Pressure Coefficient
  - m.  $GC_p$  = External Pressure Coefficient
  - n.  $C_f$  = Force Coefficient: Value determined by delegated wind-load design Contractor from ASCE/SEI 7-05, Figures 6-21 through 6-23 or other source approved by authorities having jurisdiction.
  - o.  $A_f$  = Projected Area Normal to the Wind: Except where  $C_f$  is specified for the actual surface area, value determined by delegated wind-load design Contractor from equipment submittal or manufacturer.
- D. Consequential Damage: Provide additional seismic restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7-05 ASCE/SEI 7-10 ASCE/SEI 7-16 so that failure of a non-essential or essential HVAC component will not cause failure of any other essential architectural, mechanical, or electrical building component.
- E. Fire/Smoke Resistance: Seismic- and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- F. Component Supports:
- 1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
  - 2. All component support attachments must comply with force and displacement resistance requirements of ASCE 7-05 Section 13.6 ASCE/SEI 7-10 Section 13.6 ASCE/SEI 7-16 Section 13.6.

## 2.2 ELASTOMERIC ISOLATION PADS

### A. Elastomeric Isolation Pads:.

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. [Acoustic Systems.](#)



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- b. [Advanced Antivibration Components /A VMC Group Company.](#)
  - c. [Amber/Booth Co.](#)
  - d. [ANDRE HVAC International Inc.](#)
  - e. [Cooper B-Line, Inc.](#)
  - f. [Flex-Weld / Keflex Mfg.](#)
  - g. [General Rubber Corp.](#)
  - h. [Kinetics Noise Control Inc.](#)
  - i. [Mason Industries, Inc.](#)
  - j. [MIRO Industries Inc.](#)
  - k. [Novia - A Division of Carpenter & Paterson.](#)
  - l. [PAC International, Inc.](#)
  - m. [PHP Systems Design.](#)
  - n. [Plumberex Specialty Products, Inc.](#)
  - o. [Seismic Control Products, LLC.](#)
  - p. [VMC Group.](#)
- 2. Source Limitations: Obtain elastomeric isolation pads from single manufacturer.
  - 3. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
  - 4. Size: Factory or field cut to match requirements of supported equipment.
  - 5. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
  - 6. Surface Pattern: Smooth, ribbed, or waffle pattern.
  - 7. Infused nonwoven cotton or synthetic fibers.
  - 8. Load-bearing metal plates adhered to pads.
  - 9. Sandwich-Core Material: Resilient and elastomeric.
- a. Surface Pattern: Smooth, ribbed, or waffle pattern.
  - b. Infused nonwoven cotton or synthetic fibers.

## 2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

### A. Restrained Elastomeric Isolation Mounts:.

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. [Acoustic Systems.](#)
  - b. [Advanced Antivibration Components /A VMC Group Company.](#)
  - c. [Amber/Booth Co.](#)
  - d. [ANDRE HVAC International Inc.](#)
  - e. [Cooper B-Line, Inc.](#)
  - f. [Flex-Weld / Keflex Mfg.](#)
  - g. [General Rubber Corp.](#)
  - h. [Kinetics Noise Control Inc.](#)
  - i. [Mason Industries, Inc.](#)
  - j. [MIRO Industries Inc.](#)
  - k. [Novia - A Division of Carpenter & Paterson.](#)
  - l. [PAC International, Inc.](#)



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- m. [PHP Systems Design.](#)
  - n. [Plumberex Specialty Products, Inc.](#)
  - o. [Seismic Control Products, LLC.](#)
  - p. [VMC Group.](#)
2. Source Limitations: Obtain restrained elastomeric isolation mounts from single manufacturer.
3. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
- a. Housing: Cast-ductile iron or welded steel.
  - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
- a. [Acoustic Systems.](#)
  - b. [Advanced Antivibration Components /A VMC Group Company.](#)
  - c. [Amber/Booth Co.](#)
  - d. [ANDRE HVAC International Inc.](#)
  - e. [Cooper B-Line, Inc.](#)
  - f. [Flex-Weld / Keflex Mfg.](#)
  - g. [General Rubber Corp.](#)
  - h. [Kinetics Noise Control Inc.](#)
  - i. [Mason Industries, Inc.](#)
  - j. [MIRO Industries Inc.](#)
  - k. [Novia - A Division of Carpenter & Paterson.](#)
  - l. [PAC International, Inc.](#)
  - m. [PHP Systems Design.](#)
  - n. [Plumberex Specialty Products, Inc.](#)
  - o. [Seismic Control Products, LLC.](#)
  - p. [VMC Group.](#)
2. Source Limitations: Obtain restrained-spring isolators from single manufacturer.
3. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
- a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig (3447 kPa).
  - b. Top plate with threaded mounting holes elastomeric pad.
  - c. Internal leveling bolt that acts as blocking during installation.



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4. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.5 HOUSED-RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. [Acoustic Systems.](#)
  - b. [Advanced Antivibration Components /A VMC Group Company.](#)
  - c. [Amber/Booth Co.](#)
  - d. [ANDRE HVAC International Inc.](#)
  - e. [Cooper B-Line, Inc.](#)
  - f. [Flex-Weld / Keflex Mfg.](#)
  - g. [General Rubber Corp.](#)
  - h. [Kinetics Noise Control Inc.](#)
  - i. [Mason Industries, Inc.](#)
  - j. [MIRO Industries Inc.](#)
  - k. [Novia - A Division of Carpenter & Paterson.](#)
  - l. [PAC International, Inc.](#)
  - m. [PHP Systems Design.](#)
  - n. [Plumberex Specialty Products, Inc.](#)
  - o. [Seismic Control Products, LLC.](#)
  - p. [VMC Group.](#)
2. Source Limitations: Obtain freestanding, open-spring isolators with vertical-limit stop restraints from single manufacturer.
3. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
  - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig (3447 kPa).
  - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.



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7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.6 PIPE-RISER RESILIENT SUPPORT

- A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene:.

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
  - a. [Acoustic Systems.](#)
  - b. [Advanced Antivibration Components /A VMC Group Company.](#)
  - c. [Amber/Booth Co.](#)
  - d. [ANDRE HVAC International Inc.](#)
  - e. [Cooper B-Line, Inc.](#)
  - f. [Flex-Weld / Keflex Mfg.](#)
  - g. [General Rubber Corp.](#)
  - h. [Kinetics Noise Control Inc.](#)
  - i. [Mason Industries, Inc.](#)
  - j. [MIRO Industries Inc.](#)
  - k. [Novia - A Division of Carpenter & Paterson.](#)
  - l. [PAC International, Inc.](#)
  - m. [PHP Systems Design.](#)
  - n. [Plumberex Specialty Products, Inc.](#)
  - o. [Seismic Control Products, LLC.](#)
  - p. [VMC Group.](#)
2. Source Limitations: Obtain all-directional, acoustical pipe anchor from single manufacturer.
3. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
4. Maximum Load Per Support: 500 psig (3447 kPa) on isolation material providing equal isolation in all directions.

## 2.7 RESILIENT PIPE GUIDES

- A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene:.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. [Acoustic Systems.](#)
  - b. [Advanced Antivibration Components /A VMC Group Company.](#)
  - c. [Amber/Booth Co.](#)
  - d. [ANDRE HVAC International Inc.](#)



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- e. [Cooper B-Line, Inc.](#)
  - f. [Flex-Weld / Keflex Mfg.](#)
  - g. [General Rubber Corp.](#)
  - h. [Kinetics Noise Control Inc.](#)
  - i. [Mason Industries, Inc.](#)
  - j. [MIRO Industries Inc.](#)
  - k. [Novia - A Division of Carpenter & Paterson.](#)
  - l. [PAC International, Inc.](#)
  - m. [PHP Systems Design.](#)
  - n. [Plumberex Specialty Products, Inc.](#)
  - o. [Seismic Control Products, LLC.](#)
  - p. [VMC Group.](#)
- 2. Source Limitations: Obtain resilient pipe guides from single manufacturer.
  - 3. Factory-Set Height Guide with Shear Pin: Shear pin to be removable and reinsertable to allow for selection of pipe movement. Guides to be capable of motion to meet location requirements.

## 2.8 RESTRAINED-AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. [Acoustic Systems.](#)
    - b. [Advanced Antivibration Components /A VMC Group Company.](#)
    - c. [Amber/Booth Co.](#)
    - d. [ANDRE HVAC International Inc.](#)
    - e. [Cooper B-Line, Inc.](#)
    - f. [Flex-Weld / Keflex Mfg.](#)
    - g. [General Rubber Corp.](#)
    - h. [Kinetics Noise Control Inc.](#)
    - i. [Mason Industries, Inc.](#)
    - j. [MIRO Industries Inc.](#)
    - k. [Novia - A Division of Carpenter & Paterson.](#)
    - l. [PAC International, Inc.](#)
    - m. [PHP Systems Design.](#)
    - n. [Plumberex Specialty Products, Inc.](#)
    - o. [Seismic Control Products, LLC.](#)
    - p. [VMC Group.](#)
  - 2. Source Limitations: Obtain restrained-air-spring isolators from single manufacturer.
  - 3. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.



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- a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig (3447 kPa).
  - b. Top plate with threaded mounting holes elastomeric pad.
  - c. Internal leveling bolt that acts as blocking during installation.
4. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
  5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  8. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
  9. Maximum Natural Frequency: 3 Hz.
  10. Operating Pressure Range: 25 to 100 psig (172 to 690 kPa).
  11. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
  12. Automatic leveling valve.

## 2.9 ELASTOMERIC HANGERS

### A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. [Acoustic Systems.](#)
  - b. [Advanced Antivibration Components /A VMC Group Company.](#)
  - c. [Amber/Booth Co.](#)
  - d. [ANDRE HVAC International Inc.](#)
  - e. [Cooper B-Line, Inc.](#)
  - f. [Flex-Weld / Keflex Mfg.](#)
  - g. [General Rubber Corp.](#)
  - h. [Kinetics Noise Control Inc.](#)
  - i. [Mason Industries, Inc.](#)
  - j. [MIRO Industries Inc.](#)
  - k. [Novia - A Division of Carpenter & Paterson.](#)
  - l. [PAC International, Inc.](#)
  - m. [PHP Systems Design.](#)
  - n. [Plumberex Specialty Products, Inc.](#)
  - o. [Seismic Control Products, LLC.](#)
  - p. [VMC Group.](#)
2. Source Limitations: Obtain elastomeric hangers from a single manufacturer.
3. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.



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4. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

## 2.10 SPRING HANGERS

### A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
  - a. [Acoustic Systems.](#)
  - b. [Advanced Antivibration Components /A VMC Group Company.](#)
  - c. [Amber/Booth Co.](#)
  - d. [ANDRE HVAC International Inc.](#)
  - e. [Cooper B-Line, Inc.](#)
  - f. [Flex-Weld / Keflex Mfg.](#)
  - g. [General Rubber Corp.](#)
  - h. [Kinetics Noise Control Inc.](#)
  - i. [Mason Industries, Inc.](#)
  - j. [MIRO Industries Inc.](#)
  - k. [Novia - A Division of Carpenter & Paterson.](#)
  - l. [PAC International, Inc.](#)
  - m. [PHP Systems Design.](#)
  - n. [Plumberex Specialty Products, Inc.](#)
  - o. [Seismic Control Products, LLC.](#)
  - p. [VMC Group.](#)
2. Source Limitations: Obtain spring hangers from single manufacturer.
3. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
10. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.



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2.11 SNUBBERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following] [provide products by one of the following:
1. [Acoustic Systems.](#)
  2. [Advanced Antivibration Components /A VMC Group Company.](#)
  3. [Amber/Booth Co.](#)
  4. [ANDRE HVAC International Inc.](#)
  5. [Cooper B-Line, Inc.](#)
  6. [Flex-Weld / Keflex Mfg.](#)
  7. [General Rubber Corp.](#)
  8. [Kinetics Noise Control Inc.](#)
  9. [Mason Industries, Inc.](#)
  10. [MIRO Industries Inc.](#)
  11. [Novia - A Division of Carpenter & Paterson.](#)
  12. [PAC International, Inc.](#)
  13. [PHP Systems Design.](#)
  14. [Plumberex Specialty Products, Inc.](#)
  15. [Seismic Control Products, LLC.](#)
  16. [VMC Group.](#)
- B. Source Limitations: Obtain snubbers from single manufacturer.
- C. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-08 Appendix D for 2009 IBC ACI 318-11 Appendix D for 2012 IBC ACI 318-14 Ch. 17 for 2015 or 2018 IBC.
  2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
  3. Anchors in Masonry: Design in accordance with TMS 402.
  4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
  5. Resilient Cushion: Maximum 1/4-inch (6-mm) air gap, and minimum 1/4 inch (6 mm) thick.

2.12 RESTRAINTS - RIGID TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. [Acoustic Systems.](#)
  2. [Advanced Antivibration Components /A VMC Group Company.](#)
  3. [Amber/Booth Co.](#)
  4. [ANDRE HVAC International Inc.](#)



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5. [Cooper B-Line, Inc.](#)
6. [Flex-Weld / Keflex Mfg.](#)
7. [General Rubber Corp.](#)
8. [Kinetics Noise Control Inc.](#)
9. [Mason Industries, Inc.](#)
10. [MIRO Industries Inc.](#)
11. [Novia - A Division of Carpenter & Paterson.](#)
12. [PAC International, Inc.](#)
13. [PHP Systems Design.](#)
14. [Plumberex Specialty Products, Inc.](#)
15. [Seismic Control Products, LLC.](#)
16. [VMC Group.](#)

- B. Source Limitations: Obtain rigid-type restraints from single manufacturer.
- C. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.13 RESTRAINTS - CABLE TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. [Acoustic Systems.](#)
  2. [Advanced Antivibration Components /A VMC Group Company.](#)
  3. [Amber/Booth Co.](#)
  4. [ANDRE HVAC International Inc.](#)
  5. [Cooper B-Line, Inc.](#)
  6. [Flex-Weld / Keflex Mfg.](#)
  7. [General Rubber Corp.](#)
  8. [Kinetics Noise Control Inc.](#)
  9. [Mason Industries, Inc.](#)
  10. [MIRO Industries Inc.](#)
  11. [Novia - A Division of Carpenter & Paterson.](#)
  12. [PAC International, Inc.](#)
  13. [PHP Systems Design.](#)
  14. [Plumberex Specialty Products, Inc.](#)
  15. [Seismic Control Products, LLC.](#)
  16. [VMC Group.](#)
- B. Source Limitations: Obtain cable-type restraints from single manufacturer.
- C. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining



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cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

- D. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

## 2.14 RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. [Acoustic Systems.](#)
2. [Advanced Antivibration Components /A VMC Group Company.](#)
3. [Amber/Booth Co.](#)
4. [ANDRE HVAC International Inc.](#)
5. [Cooper B-Line, Inc.](#)
6. [Flex-Weld / Keflex Mfg.](#)
7. [General Rubber Corp.](#)
8. [Kinetics Noise Control Inc.](#)
9. [Mason Industries, Inc.](#)
10. [MIRO Industries Inc.](#)
11. [Novia - A Division of Carpenter & Paterson.](#)
12. [PAC International, Inc.](#)
13. [PHP Systems Design.](#)
14. [Plumberex Specialty Products, Inc.](#)
15. [Seismic Control Products, LLC.](#)
16. [VMC Group.](#)

- B. Source Limitations: Obtain restraint accessories from single manufacturer.
- C. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.
- D. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- E. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.



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2.15 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. [Acoustic Systems.](#)
  - b. [Advanced Antivibration Components /A VMC Group Company.](#)
  - c. [Amber/Booth Co.](#)
  - d. [ANDRE HVAC International Inc.](#)
  - e. [Cooper B-Line, Inc.](#)
  - f. [Flex-Weld / Keflex Mfg.](#)
  - g. [General Rubber Corp.](#)
  - h. [Kinetics Noise Control Inc.](#)
  - i. [Mason Industries, Inc.](#)
  - j. [MIRO Industries Inc.](#)
  - k. [Novia - A Division of Carpenter & Paterson.](#)
  - l. [PAC International, Inc.](#)
  - m. [PHP Systems Design.](#)
  - n. [Plumberex Specialty Products, Inc.](#)
  - o. [Seismic Control Products, LLC.](#)
  - p. [VMC Group.](#)
2. Source Limitations: Obtain mechanical anchor bolts from single manufacturer.
3. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. [Acoustic Systems.](#)
  - b. [Advanced Antivibration Components /A VMC Group Company.](#)
  - c. [Amber/Booth Co.](#)
  - d. [ANDRE HVAC International Inc.](#)
  - e. [Cooper B-Line, Inc.](#)
  - f. [Flex-Weld / Keflex Mfg.](#)
  - g. [General Rubber Corp.](#)
  - h. [Kinetics Noise Control Inc.](#)
  - i. [Mason Industries, Inc.](#)
  - j. [MIRO Industries Inc.](#)
  - k. [Novia - A Division of Carpenter & Paterson.](#)
  - l. [PAC International, Inc.](#)
  - m. [PHP Systems Design.](#)
  - n. [Plumberex Specialty Products, Inc.](#)
  - o. [Seismic Control Products, LLC.](#)
  - p. [VMC Group.](#)



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2. Source Limitations: Obtain adhesive anchor bolts from single manufacturer.
  3. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-05, Ch. 13 ASCE/SEI 7-10, Ch. 13 ASCE/SEI 7-16, Ch. 13.
1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
  2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.
- D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW) that is not vibration isolated.
1. Undercut expansion anchors are permitted.

## 2.16 CONCRETE INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. [Acoustic Systems.](#)
  2. [Advanced Antivibration Components /A VMC Group Company.](#)
  3. [Amber/Booth Co.](#)
  4. [ANDRE HVAC International Inc.](#)
  5. [Cooper B-Line, Inc.](#)
  6. [Flex-Weld / Keflex Mfg.](#)
  7. [General Rubber Corp.](#)
  8. [Kinetics Noise Control Inc.](#)
  9. [Mason Industries, Inc.](#)
  10. [MIRO Industries Inc.](#)
  11. [Novia - A Division of Carpenter & Paterson.](#)
  12. [PAC International, Inc.](#)
  13. [PHP Systems Design.](#)
  14. [Plumberex Specialty Products, Inc.](#)
  15. [Seismic Control Products, LLC.](#)
  16. [VMC Group.](#)
- B. Source Limitations: Obtain concrete inserts from single manufacturer.
- C. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.



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- D. Comply with ANSI/MSS SP-58.

2.17 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. [Acoustic Systems.](#)
2. [Advanced Antivibration Components /A VMC Group Company.](#)
3. [Amber/Booth Co.](#)
4. [ANDRE HVAC International Inc.](#)
5. [Cooper B-Line, Inc.](#)
6. [Flex-Weld / Keflex Mfg.](#)
7. [General Rubber Corp.](#)
8. [Kinetics Noise Control Inc.](#)
9. [Mason Industries, Inc.](#)
10. [MIRO Industries Inc.](#)
11. [Novia - A Division of Carpenter & Paterson.](#)
12. [PAC International, Inc.](#)
13. [PHP Systems Design.](#)
14. [Plumberex Specialty Products, Inc.](#)
15. [Seismic Control Products, LLC.](#)
16. [VMC Group.](#)

- B. Source Limitations: Obtain vibration isolation equipment bases from single manufacturer.

- C. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
  - a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails to have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

- D. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
  - a. Include supports for suction and discharge elbows for pumps.



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2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- E. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
  4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.



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- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static, wind load, and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION-CONTROL, WIND-LOAD CONTROL, AND SEISMIC-RESTRAINT DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.
- B. Provide seismic-restraint and wind-load control devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."
- D. Installation of vibration isolators, wind-load restraints, must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- E. Comply with requirements in Section 07 72 00 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- F. Equipment Restraints:
  - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
  - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
  - 3. Install seismic-restraint, and wind-load-restraint devices using methods approved by an evaluation service member of ICC-ES an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
  - 2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
  - 3. Brace a change of direction longer than 12 feet (3.7 m).
- H. Ductwork Restraints:



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1. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
  2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
  3. Brace a change of direction longer than 12 feet (3.7 m).
  4. Select seismic-restraint devices with capacities adequate to carry static and seismic loads.
  5. Install cable restraints on ducts that are suspended with vibration isolators.
- I. Install seismic- and wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.
- J. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- K. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- L. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- M. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- N. Mechanical Anchor Bolts:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
  5. Set anchors to manufacturer's recommended torque, using a torque wrench.
  6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.



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3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 "Hydronic Piping Specialties" for piping flexible connections.

3.5 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

- A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."
- B. Coordinate dimensions of steel equipment rails and bases, concrete inertia bases, and restrained isolation roof-curb rails with requirements of isolated equipment specified in this and other Sections. Where dimensions of these bases are indicated on Drawings, dimensions may require adjustment to accommodate actual isolated equipment.

3.6 ADJUSTING

- A. Adjust isolators after system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
  - 1. Perform tests and inspections with the assistance of a factory-authorized service representative.
  - 2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  - 3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
  - 4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.



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5. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
  6. Test to 90 percent of rated proof load of device.
  7. Measure isolator restraint clearance.
  8. Measure isolator deflection.
  9. Verify snubber minimum clearances.
  10. Test and adjust restrained-air-spring isolator controls and safeties.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

**END OF SECTION 23 05 48**



## **SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Equipment labels.
2. Warning signs and labels.
3. Warning tape.
4. Pipe labels.
5. Duct labels.
6. Stencils.
7. Valve tags.
8. Warning tags.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data:** For each type of product.
- B. Samples:** For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule:** Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve-numbering scheme.**
- E. Valve Schedules:** Provide for each piping system. Include in operation and maintenance manuals.

### **PART 2 - PRODUCTS**

#### **2.1 EQUIPMENT LABELS**

- A. Plastic Labels for Equipment:**



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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Brimar Industries, Inc.
  - c. Carlton Industries, LP.
  - d. Champion America.
  - e. Craftmark Pipe Markers.
  - f. emedco.
  - g. Kolbi Pipe Marker Co.
  - h. LEM Products Inc.
  - i. Marking Services, Inc.
  - j. Seton Identification Products; a Brady Corporation company.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

## 2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
  2. Brimar Industries, Inc.
  3. Carlton Industries, LP.
  4. Champion America.
  5. Craftmark Pipe Markers.
  6. emedco.
  7. LEM Products Inc.
  8. Marking Services Inc.
  9. National Marker Company.
  10. Seton Identification Products; a Brady Corporation company.



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11. Stranco, Inc.

- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, with predrilled holes for attachment hardware.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless steel rivets or self-taping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  - 2. Brady Corporation.
  - 3. Brimar Industries, Inc.
  - 4. Carlton Industries, LP.
  - 5. Champion America.
  - 6. Craftmark Pipe Markers.
  - 7. emedco.
  - 8. Kolbi Pipe Marker Co.
  - 9. LEM Products Inc.
  - 10. Marking Services Inc.
  - 11. Seton Identification Products; a Brady Corporation company.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.



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- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
1. Pipe size.
  2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
  3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.4 DUCT LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
  2. Brimar Industries, Inc.
  3. Carlton Industries, LP.
  4. Champion America.
  5. Craftmark Pipe Markers.
  6. emedco.
  7. Kolbi Pipe Marker Co.
  8. LEM Products Inc.
  9. Marking Services Inc.
  10. Seton Identification Products; a Brady Corporation company.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless steel rivets or self-tapping screws.
- H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:
1. Duct size.
  2. Flow-Direction Arrows: Include flow-direction arrows on distribution ducts. Arrows may be either integral with label or may be applied separately.
  3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.



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2.5 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  2. Brady Corporation.
  3. Brimar Industries, Inc.
  4. Carlton Industries, LP.
  5. Champion America.
  6. Craftmark Pipe Markers.
  7. emedco.
  8. Kolbi Pipe Marker Co.
  9. LEM Products Inc.
  10. Marking Services Inc.
  11. Seton Identification Products; a Brady Corporation company.
- B. Description: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
1. Tag Material: Brass, 0.04-inch (1.0-mm) or stainless steel, 0.024-inch (0.61-mm) minimum thickness, with predrilled or stamped holes for attachment hardware.
  2. Fasteners: Brass beaded chain.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Include valve-tag schedule in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.



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- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of mechanical equipment.
- B. Sign and Label Colors:
  - 1. White letters on an ANSI Z535.1 safety-blue background.
- C. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF PIPE LABELS

- A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Within 3 ft. (1 m) of each valve and control device.
  - 2. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 3. Within 3 ft. (1 m) of equipment items and other points of origination and termination.
  - 4. Spaced at maximum intervals of 25 ft. (8 m) along each run. Reduce intervals to 10 ft. (3.0 m) in areas of congested piping, ductwork, and equipment. For piping above ceilings in occupied spaces, provide a label on piping above each room.
- C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- D. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe-Label Color Schedule:
  - 1. Chilled-Water Piping: White letters on an ANSI Z535.1 safety-green background.
  - 2. Condenser-Water Piping: White letters on an ANSI Z535.1 safety-green background.



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3. Heating Water Piping: White letters on an ANSI Z535.1 safety-green background.
4. Refrigerant Piping: White letters on an ANSI Z535.1 safety-blue background.
5. Low-Pressure Steam Piping: Black letters on an ANSI Z535.1 safety-yellow background.
6. High-Pressure Steam Piping: Black letters on an ANSI Z535.1 safety-yellow background.
7. Steam Condensate Piping: Black letters on an ANSI Z535.1 safety-yellow background.
8. Toxic and Corrosive Fluids: Black letters on an ANSI Z535.1 safety-orange background.
9. Flammable Fluids: Black letters on an ANSI Z535.1 safety-yellow background.
10. Combustible Fluids: White letters on an ANSI Z535.1 safety-brown background.
11. Potable and Other Water: White letters on an ANSI Z535.1 safety-green background.
12. Compressed Air: White letters on an ANSI Z535.1 safety-blue background.

### 3.5 INSTALLATION OF DUCT LABELS

- A. Install plastic-laminated duct labels showing service and flow direction with permanent adhesive on air ducts.
  1. Provide labels in the following color codes:
    - a. For air supply ducts: White letters on blue background.
    - b. For air return ducts: White letters on blue background.
    - c. For exhaust-, outside-, relief-, return-, and mixed-air ducts: White letters on blue background.
- B. Locate label near each point where ducts enter into and exit from concealed spaces and at maximum intervals of 20 ft. (6 m) where exposed or are concealed by removable ceiling system. For ductwork above ceilings in occupied spaces, provide a label on ductwork above each room.

### 3.6 INSTALLATION OF VALVE TAGS

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.
  1. Valve-Tag Size and Shape:
    - a. Chilled Water: 1-1/2 inches (38 mm), round.
    - b. Condenser Water: 1-1/2 inches (38 mm), round.
    - c. Refrigerant: 1-1/2 inches (38 mm), round.



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- d. Hot Water: 1-1/2 inches (38 mm), round.
- e. Gas: 1-1/2 inches (38 mm), round.
- f. Low-Pressure Steam: 1-1/2 inches (38 mm), round.
- g. High-Pressure Steam: 1-1/2 inches (38 mm), round.
- h. Steam Condensate: 1-1/2 inches (38 mm), round.

**END OF SECTION 23 05 53**



## **SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Testing, Adjusting, and Balancing of Air Systems:
    - a. Constant-volume air systems.
    - b. Variable-air-volume systems.
  - 2. Sound tests.
  - 3. Vibration tests.
  - 4. Duct leakage tests verification.
  - 5. Pipe leakage tests verification.
  - 6. HVAC-control system verification.

#### **1.3 DEFINITIONS**

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.
- G. UFAD: Underfloor air distribution.



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1.4 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at **Project site** after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of **14** days' advance notice of scheduled meeting time and location.
  - 1. Minimum Agenda Items:
    - a. The Contract Documents examination report.
    - b. The TAB plan.
    - c. Needs for coordination and cooperation of trades and subcontractors.
    - d. Proposed procedures for documentation and communication flow.

1.5 ACTION SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. HVAC Flush Report: Documentation indicating that building HVAC system flush complies with Green Globes Section 3.1.2.4 "IAQ During Construction."

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within **30** days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within **30** days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within **30** days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
- D. System Readiness Checklists: Within **30** days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.



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3. Application.
4. Dates of use.
5. Dates of calibration.

1.7 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by AABC:
  1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
  2. TAB Technician: Employee of the TAB specialist and certified by AABC.
- B. TAB Specialists Qualifications, Certified by **NEBB or TABB**:
  1. TAB Field Supervisor: Employee of the TAB specialist and certified by **NEBB or TABB**.
  2. TAB Technician: Employee of the TAB specialist and certified by **NEBB or TABB**.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
  1. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
- E. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.8 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.



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PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.
- F. Examine equipment performance data, including fan and pump curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.



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- K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.
- L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.
- Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
  - 1. Equipment and systems to be tested.
  - 2. Strategies and step-by-step procedures for balancing the systems.
  - 3. Instrumentation to be used.
  - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
  - 1. Airside:
    - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
    - b. Duct systems are complete with terminals installed.
    - c. Volume, smoke, and fire dampers are open and functional.
    - d. Clean filters are installed.
    - e. Fans are operating, free of vibration, and rotating in correct direction.
    - f. Variable-frequency controllers' startup is complete and safeties are verified.
    - g. Automatic temperature-control systems are operational.
    - h. Ceilings are installed.
    - i. Windows and doors are installed.
    - j. Suitable access to balancing devices and equipment is provided.



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3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in **AABC's "National Standards for Total System Balance"** **NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems"** and in this Section.
- B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "Air Duct Accessories."
  - 3. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
  - 4. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 23 07 13 "Duct Insulation,"
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in **inch-pound (IP)** units.

3.4 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

- A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
  - 1. Motors.
  - 2. Pumps.
  - 3. Fans and ventilators.
  - 4. Air curtains.
  - 5. Terminal units.
  - 6. Commercial kitchen hoods.
  - 7. Boilers.
  - 8. Deaerators.
  - 9. Furnaces.
  - 10. Radiant heaters.
  - 11. Unit heaters.
  - 12. Solar collectors.
  - 13. Heat exchangers.
  - 14. Condensing units.
  - 15. Condensers.
  - 16. Water chillers.
  - 17. Cooling towers.



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18. Energy-recovery units.
19. Air-handling units.
20. Heating and ventilating units.
21. Rooftop air-conditioning units.
22. Heating-only makeup air units.
23. Dedicated outdoor-air units.
24. Packaged air conditioners.
25. Self-contained air conditioners.
26. Computer-room air conditioners.
27. Split-system air conditioners.
28. Variable-refrigerant-flow systems.
29. Heat pumps.
30. Valance heating and cooling units.
31. Chilled beams.
32. Coils.
33. Fan coil units.
34. Unit ventilators.
35. Radiators.
36. Convectors.
37. Finned-tube radiation heaters.
38. Radiant-heating
39. Humidifiers.
40. Dehumidification units.

### 3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' Record drawings duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.



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- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
    - c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
  - 2. Measure fan static pressures as follows:
    - a. Measure static pressure directly at the fan outlet or through the flexible connection.
    - b. Measure static pressure directly at the fan inlet or through the flexible connection.
    - c. Measure static pressure across each component that makes up the air-handling system.
    - d. Report artificial loading of filters at the time static pressures are measured.
  - 3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  - 4. Obtain approval from **Commissioning Authority** for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  - 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
  - 1. Measure airflow of submain and branch ducts.
  - 2. Adjust submain and branch duct volume dampers for specified airflow.



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3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
  1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
  2. Measure inlets and outlets airflow.
  3. Adjust each inlet and outlet for specified airflow.
  4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
  1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
  2. Re-measure and confirm that total airflow is within design.
  3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
  4. Mark all final settings.
  5. Test system in economizer mode. Verify proper operation and adjust if necessary.
  6. Measure and record all operating data.
  7. Record final fan-performance data.

### 3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Adjust the variable-air-volume systems as follows:
  1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
  2. Verify that the system is under static pressure control.
  3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
  4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
    - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    - d. Adjust controls so that terminal is calling for minimum airflow.
    - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.



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- f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
- a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
  - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
  - c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
  - d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
6. Measure fan static pressures as follows:
- a. Measure static pressure directly at the fan outlet or through the flexible connection.
  - b. Measure static pressure directly at the fan inlet or through the flexible connection.
  - c. Measure static pressure across each component that makes up the air-handling system.
  - d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
- a. Balance the return-air ducts and inlets.
  - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:
- a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
  - b. Re-measure and confirm that total airflow is within design.
  - c. Re-measure final fan operating data, speed, volts, amps, and static profile.
  - d. Mark final settings.



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- e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
- f. Verify tracking between supply and return fans.

### 3.8 PROCEDURES FOR MOTORS

- A. Motors ½ HP and Larger: Test at final balanced conditions and record the following data:
  - 1. Manufacturer's name, model number, and serial number.
  - 2. Motor horsepower rating.
  - 3. Motor rpm.
  - 4. Phase and hertz.
  - 5. Nameplate and measured voltage, each phase.
  - 6. Nameplate and measured amperage, each phase.
  - 7. Starter size and thermal-protection-element rating.
  - 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

### 3.9 SOUND TESTS

- A. After systems are balanced and Substantial Completion, measure and record sound levels at **five** locations as designated by the Architect.
- B. Instrumentation:
  - 1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
  - 2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level ( $L_{eq}$ ).
  - 3. The sound-testing meter must be capable of using one-third octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
  - 4. The accuracy of the sound-testing meter shall be plus or minus one decibel.
- C. Test Procedures:
  - 1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
  - 2. Equipment should be operating at design values.
  - 3. Calibrate the sound-testing meter prior to taking measurements.
  - 4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.



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5. Record a set of background measurements in dBA and sound pressure levels in the eight unweighted octave bands **63 Hz to 8000 Hz (NC) 31.5 Hz to 4000 Hz (RC)** with the equipment off.
6. Take sound readings in dBA and sound pressure levels in the eight unweighted octave bands **63 Hz to 8000 Hz (NC) 31.5 Hz to 4000 Hz (RC)** with the equipment operating.
7. Take readings no closer than 36 inches (900 mm) from a wall or from the operating equipment and approximately 60 inches (1500 mm) from the floor, with the meter held or mounted on a tripod.
8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:
  - a. Location.
  - b. System tested.
  - c. dBA reading.
  - d. Sound pressure level in each octave band with equipment on and off.
2. Plot sound pressure levels on **Noise Criteria (NC)** worksheet with equipment on and off.

3.10 VIBRATION TESTS

- A. After systems are balanced and Substantially Completion, measure and record vibration levels on equipment having motor horsepower equal to or greater than **10**
- B. Instrumentation:
  1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
  2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
  3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
  4. Verify calibration date is current for vibration meter before taking readings.
- C. Test Procedures:
  1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
  2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then



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move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.

3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
4. Record CPM or rpm.
5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.

D. Reporting:

1. Report shall record location and the system tested.
2. Include horizontal-vertical-axial measurements for tests.
3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from AABC's "National Standards for Total System Balance." Acceptable levels of vibration are normally "smooth" to "good."
4. Include in General Machinery Vibration Severity Chart, with conditions plotted.

3.11 DUCT LEAKAGE TESTS

- A. Witness the duct leakage testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

3.12 PIPE LEAKAGE TESTS

- A. Witness the pipe pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

3.13 HVAC CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
  1. Verify HVAC control system is operating within the design limitations.
  2. Confirm that the sequences of operation are in compliance with Contract Documents.
  3. Verify that controllers are calibrated and function as intended.
  4. Verify that controller set points are as indicated.



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5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

### 3.14 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: **Plus or minus 10 percent** If design value is less than 100 cfm (47 L/s), within 10 cfm (4.7 L/s).
2. Air Outlets and Inlets: **Plus or minus 10 percent**. If design value is less than 100 cfm (47 L/s), within 10 cfm (4.7 L/s).

- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

### 3.15 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare **weekly** progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### 3.16 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  2. Include a list of instruments used for procedures, along with proof of calibration.



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3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
  2. Fan curves.
  3. Manufacturers' test data.
  4. Field test reports prepared by system and equipment installers.
  5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
  2. Name and address of the TAB specialist.
  3. Project name.
  4. Project location.
  5. Architect's name and address.
  6. Engineer's name and address.
  7. Contractor's name and address.
  8. Report date.
  9. Signature of TAB supervisor who certifies the report.
  10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  11. Summary of contents, including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  12. Nomenclature sheets for each item of equipment.
  13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  14. Notes to explain why certain final data in the body of reports vary from indicated values.
  15. Test conditions for fans performance forms, including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.
    - d. Heating coil, dry-bulb conditions.
    - e. Face and bypass damper settings at coils.
    - f. Fan drive settings, including settings and percentage of maximum pitch diameter.
    - g. **Variable-frequency controller** settings for variable-air-volume systems.
    - h. Settings for pressure controller(s).
    - i. Other system operating conditions that affect performance.
  16. Test conditions for pump performance forms, including the following:



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- a. Variable-frequency controller settings for variable-flow hydronic systems.
  - b. Settings for pressure controller(s).
  - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
  - 1. Quantities of outdoor, supply, return, and exhaust airflows.
  - 2. Water and steam flow rates.
  - 3. Duct, outlet, and inlet sizes.
  - 4. Pipe and valve sizes and locations.
  - 5. Terminal units.
  - 6. Balancing stations.
  - 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units, include the following:
  - 1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Unit arrangement and class.
    - g. Discharge arrangement.
    - h. Sheave make, size in inches (mm), and bore.
    - i. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
    - j. Number, make, and size of belts.
    - k. Number, type, and size of filters.
  - 2. Motor Data:
    - a. Motor make, and frame type and size.
    - b. Horsepower and speed.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches (mm), and bore.
    - f. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
  - 3. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm (L/s).
    - b. Total system static pressure in inches wg (Pa).
    - c. Fan speed.
    - d. Inlet and discharge static pressure in inches wg (Pa).
    - e. For each filter bank, filter static-pressure differential in inches wg (Pa).



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- f. Preheat-coil static-pressure differential in inches wg (Pa).
- g. Cooling-coil static-pressure differential in inches wg (Pa).
- h. Heating-coil static-pressure differential in inches wg (Pa).
- i. List for each internal component with pressure-drop, static-pressure differential in inches wg (Pa).
- j. Outdoor airflow in cfm (L/s).
- k. Return airflow in cfm (L/s).
- l. Outdoor-air damper position.
- m. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch (mm) o.c.
- f. Make and model number.
- g. Face area in sq. ft. (sq. m).
- h. Tube size in NPS (DN).
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm (L/s).
- b. Average face velocity in fpm (m/s).
- c. Air pressure drop in inches wg (Pa).
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
- e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
- f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
- g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
- h. Refrigerant expansion valve and refrigerant types.
- i. Refrigerant suction pressure in psig (kPa).
- j. Refrigerant suction temperature in deg F (deg C).

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in inches (mm), and bore.



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- h. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
  - 2. Motor Data:
    - a. Motor make, and frame type and size.
    - b. Horsepower and speed.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches (mm), and bore.
    - f. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
    - g. Number, make, and size of belts.
  - 3. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm (L/s).
    - b. Total system static pressure in inches wg (Pa).
    - c. Fan speed.
    - d. Discharge static pressure in inches wg (Pa).
    - e. Suction static pressure in inches wg (Pa).
- H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
  - 1. Report Data:
    - a. System fan and air-handling-unit number.
    - b. Location and zone.
    - c. Traverse air temperature in deg F (deg C).
    - d. Duct static pressure in inches wg (Pa).
    - e. Duct size in inches (mm).
    - f. Duct area in sq. ft. (sq. m).
    - g. Indicated airflow rate in cfm (L/s).
    - h. Indicated velocity in fpm (m/s).
    - i. Actual airflow rate in cfm (L/s).
    - j. Actual average velocity in fpm (m/s).
    - k. Barometric pressure in psig (Pa).
- I. Air-Terminal-Device Reports:
  - 1. Unit Data:
    - a. System and air-handling unit identification.
    - b. Location and zone.
    - c. Apparatus used for test.
    - d. Area served.
    - e. Make.
    - f. Number from system diagram.



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- g. Type and model number.
    - h. Size.
    - i. Effective area in sq. ft. (sq. m).
  - 2. Test Data (Indicated and Actual Values):
    - a. Airflow rate in cfm (L/s).
    - b. Air velocity in fpm (m/s).
    - c. Preliminary airflow rate as needed in cfm (L/s).
    - d. Preliminary velocity as needed in fpm (m/s).
    - e. Final airflow rate in cfm (L/s).
    - f. Final velocity in fpm (m/s).
    - g. Space temperature in deg F (deg C).
- J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
- 1. Unit Data:
    - a. System and air-handling-unit identification.
    - b. Location and zone.
    - c. Room or riser served.
    - d. Coil make and size.
    - e. Flowmeter type.
  - 2. Test Data (Indicated and Actual Values):
    - a. Airflow rate in cfm (L/s).
    - b. Entering-water temperature in deg F (deg C).
    - c. Leaving-water temperature in deg F (deg C).
    - d. Water pressure drop in feet of head or psig (kPa).
    - e. Entering-air temperature in deg F (deg C).
    - f. Leaving-air temperature in deg F (deg C).
- K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:
- 1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Service.
    - d. Make and size.
    - e. Model number and serial number.
    - f. Water flow rate in gpm (L/s).
    - g. Water pressure differential in feet of head or psig (kPa).
    - h. Required net positive suction head in feet of head or psig (kPa).
    - i. Pump speed.
    - j. Impeller diameter in inches (mm).



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- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig (kPa).
- b. Pump shutoff pressure in feet of head or psig (kPa).
- c. Actual impeller size in inches (mm).
- d. Full-open flow rate in gpm (L/s).
- e. Full-open pressure in feet of head or psig (kPa).
- f. Final discharge pressure in feet of head or psig (kPa).
- g. Final suction pressure in feet of head or psig (kPa).
- h. Final total pressure in feet of head or psig (kPa).
- i. Final water flow rate in gpm (L/s).
- j. Voltage at each connection.
- k. Amperage for each phase.

L. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.17 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of **Commissioning Authority**.
- B. **Commissioning Authority** shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either **10** percent of the total measurements recorded or the extent of measurements that can be accomplished in **a normal 8-hour business day**.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than **10** percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.



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- E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
  - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
  - 2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.
- F. Prepare test and inspection reports.

3.18 ADDITIONAL TESTS

- A. Within **90** days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

**END OF SECTION 23 05 93**



## **SECTION 23 07 13 - DUCT INSULATION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes insulating the following duct services:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed supply and outdoor air.
  - 3. Indoor, concealed return located in unconditioned space.
  - 4. Indoor, exposed return located in unconditioned space.
  - 5. Outdoor, concealed supply and return.
  - 6. Outdoor, exposed supply and return.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Sustainable Design Submittals:
  - 1. Product Data: For adhesives, indicating VOC content.
  - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
  - 3. Product Data: For coatings, indicating VOC content.
  - 4. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
  - 5. Product Data: For sealants, indicating VOC content.
  - 6. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.



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2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
  3. Detail application of field-applied jackets.
  4. Detail application at linkages of control devices.
- D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
1. Sheet Form Insulation Materials: 12 inches (300 mm) square.
  2. Sheet Jacket Materials: 12 inches (300 mm) square.
  3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.



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1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type II for sheet materials.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:



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2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Aeroflex USA.
  - b. Armacell LLC.
  - c. K-Flex USA.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. CertainTeed Corporation; Saint-Gobain North America.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. Manson Insulation Inc.
    - e. Owens Corning.
- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. CertainTeed Corporation; Saint-Gobain North America.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. Manson Insulation Inc.
    - e. Owens Corning.

## 2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F (927 deg C). Comply with ASTM C656, Type II, Grade 6. Tested and certified to provide a 1 -hour fire rating by an NRTL acceptable to authorities having jurisdiction.
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.



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- B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 1 -hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. 3M.
3. Thermal Ceramics.
4. Unifrax Corporation.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Aeroflex USA.
  - b. Armacell LLC.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. K-Flex USA.
3. Verify adhesives have a VOC content of 50 g/L or less.
4. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.

- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. Mon-Eco Industries, Inc.



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3. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
  4. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Mon-Eco Industries, Inc.
  3. Verify adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
  4. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. P.I.C. Plastics, Inc.
    - c. Speedline Corporation.
  3. Verify adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
  4. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.



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2.4 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
1. VOC Emissions: Verify mastic coatings contain no more than half of the chronic REL of VOCs when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.
- B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Knauf Insulation.
    - d. Vimasco Corporation.
  3. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
  4. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
  5. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
  6. Color: White.
- C. Vapor-Retarder Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Mon-Eco Industries, Inc.
  3. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
  4. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
  5. Color: White.



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- D. Vapor-Retarder Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
  3. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
  4. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
  5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Knauf Insulation.
    - e. Mon-Eco Industries, Inc.
    - f. Vimasco Corporation.
  3. Water-Vapor Permeance: ASTM E96, greater than 1.0 perm (0.66 metric perms) at manufacturer's recommended dry film thickness.
  4. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
  5. Color: White.

## 2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.



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- c. Vimasco Corporation.
- 3. Verify adhesives have a VOC content of 50 g/L or less.
- 4. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.
- 5. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
- 6. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
- 7. Color: White.

## 2.6 SEALANTS

### A. FSK and Metal Jacket Flashing Sealants:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. Mon-Eco Industries, Inc.
- 3. Materials shall be compatible with insulation materials, jackets, and substrates.
- 4. Fire- and water-resistant, flexible, elastomeric sealant.
- 5. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
- 6. Color: Aluminum.
- 7. Verify sealant has a VOC content of 420 g/L or less.
- 8. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.

### B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Foster Brand; H. B. Fuller Construction Products.



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3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
6. Color: White.
7. Verify sealant has a VOC content of 420 g/L or less.
8. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.

## 2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
  1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
  2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
  3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
  4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
  5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

## 2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm) for covering ducts.
- B. Manufacturers: Subject to compliance with requirements, provide products by the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  1. Childers Brand; H. B. Fuller Construction Products.
- D. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for ducts.



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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Foster Brand; H. B. Fuller Construction Products.
  - b. Vimasco Corporation.

2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Alpha Associates, Inc.

2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. P.I.C. Plastics, Inc.
    - c. Proto Corporation.
    - d. Speedline Corporation.
  3. Adhesive: As recommended by jacket material manufacturer.
  4. Color: White.
- D. Metal Jacket:
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. RPR Products, Inc.



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3. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - a. Sheet and roll stock ready for shop or field sizing.
  - b. Finish and thickness are indicated in field-applied jacket schedules.
  - c. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
  - d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
4. Stainless-Steel Jacket: ASTM A167 or ASTM A240/A240M.
  - a. Sheet and roll stock ready for shop or field sizing.
  - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
  - c. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
  - d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
- E. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with stucco-embossed aluminum-foil facing.
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Polyguard Products, Inc.

## 2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Ideal Tape Co., Inc., an American Biltrite Company.
    - c. Knauf Insulation.
  3. Width: 3 inches (75 mm).
  4. Thickness: 11.5 mils (0.29 mm).
  5. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  6. Elongation: 2 percent.
  7. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  8. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.



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- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Ideal Tape Co., Inc., an American Biltrite Company.
    - c. Knauf Insulation.
  3. Width: 3 inches (75 mm).
  4. Thickness: 6.5 mils (0.16 mm).
  5. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  6. Elongation: 2 percent.
  7. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  8. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Ideal Tape Co., Inc., an American Biltrite Company.
  3. Width: 2 inches (50 mm).
  4. Thickness: 6 mils (0.15 mm).
  5. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
  6. Elongation: 500 percent.
  7. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Ideal Tape Co., Inc., an American Biltrite Company.
    - c. Knauf Insulation.
  3. Width: 2 inches (50 mm).
  4. Thickness: 3.7 mils (0.093 mm).
  5. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
  6. Elongation: 5 percent.
  7. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.



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2.12 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. RPR Products, Inc.
3. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with closed seal.
4. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with closed seal.
5. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, diameter shank, length to suit depth of insulation indicated.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - b. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Midwest Fasteners, Inc.
    - 4) Nelson Stud Welding.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - b. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - 1) AGM Industries, Inc.
    - 2) CL WARD & Family Inc.
    - 3) Gemco.
    - 4) Midwest Fasteners, Inc.
    - 5) Nelson Stud Welding.



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3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - b. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Midwest Fasteners, Inc.
  - c. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
  - d. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
  - e. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - b. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - 1) Gemco.
    - 2) Midwest Fasteners, Inc.
  - c. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
  - d. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
  - e. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - b. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:



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- 1) AGM Industries, Inc.
      - 2) Gemco.
      - 3) Midwest Fasteners, Inc.
    - c. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
    - d. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    - e. Adhesive-backed base with a peel-off protective cover.
  6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - b. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      - 1) AGM Industries, Inc.
      - 2) Gemco.
      - 3) Midwest Fasteners, Inc.
      - 4) Nelson Stud Welding.
    - c. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
  7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - b. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      - 1) Gemco.
      - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
- D. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. C & F Wire.



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2.13 CORNER ANGLES

- A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A167 or ASTM A240/A240M, Type 304.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.



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- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.



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3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
  4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
1. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
  2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."



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3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    - b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
    - e. Impale insulation over pins and attach speed washers.
    - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).



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5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
  6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    - b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
    - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be



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insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

### 3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
  1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
  2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
  1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
  1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.



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3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 07 84 13 "Penetration Firestopping."

3.9 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
  - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.



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3.11 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Outdoor, concealed supply and return.
6. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch (25 mm) thick.
2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.

B. Concealed, round and flat-oval, return-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch (25 mm) thick.
2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.

C. Concealed, rectangular, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch (25 mm) thick.
2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.

D. Concealed, rectangular, return-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch (25 mm) thick.
2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.



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- E. Concealed, supply-air plenum insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch (25 mm) thick.
  2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
  3. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.
- F. Concealed, return-air plenum insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch (25 mm) thick.
  2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
  3. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.
- G. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch (25 mm) thick.
  2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
- H. Exposed, round and flat-oval, return-air duct insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch (25 mm) thick.
  2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
- I. Exposed, rectangular, supply-air duct insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch (25 mm) thick.
  2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
- J. Exposed, rectangular, return-air duct insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch (25 mm) thick.
  2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
- K. Exposed, rectangular, outdoor-air duct insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch (25 mm) thick.
  2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
- L. Exposed, supply-air plenum insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch (25 mm) thick.



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2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
3. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

M. Exposed, return-air plenum insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch (25 mm) thick.
2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
3. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

3.13 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Concealed, round and flat-oval, supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches (75 mm) and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
2. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

C. Concealed, round and flat-oval, return-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches (75 mm) and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
2. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

D. Concealed, rectangular, supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches (75 mm) and 0.75-lb/cu. ft. (12-kg/cu. m) 1.5-lb/cu. ft. (24-kg/cu. m) nominal density.
2. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

E. Concealed, rectangular, return-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches (75 mm) and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
2. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

F. Concealed, supply-air plenum insulation shall be one of the following:



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1. Mineral-Fiber Blanket: 3 inches (75 mm) and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
  2. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- G. Concealed, return-air plenum insulation shall be one of the following:
1. Mineral-Fiber Blanket: 3 inches (75 mm) and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
  2. Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- H. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:
1. Mineral-Fiber Blanket: 3 inches (75 mm) and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
  2. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- I. Exposed, round and flat-oval, return-air duct insulation shall be one of the following:
1. Mineral-Fiber Blanket: 3 inches (75 mm) and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
  2. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- J. Exposed, rectangular, supply-air duct insulation shall be one of the following:
1. Mineral-Fiber Blanket: 3 inches (75 mm) and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
  2. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- K. Exposed, rectangular, return-air duct insulation shall be one of the following:
1. Mineral-Fiber Blanket: 3 inches (75 mm) and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
  2. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- L. Exposed, supply-air plenum insulation shall be one of the following:
1. Mineral-Fiber Blanket: 3 inches (75 mm) and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
  2. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- M. Exposed, return-air plenum insulation shall be one of the following:



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1. Mineral-Fiber Blanket: 3 inches (75 mm) and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
2. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
  1. Aluminum, Smooth: 0.020 inch (0.51 mm) thick.
  2. Stainless Steel, Type 304, Smooth 2B Finish: 0.020 inch (0.51 mm) thick.
- D. Ducts and Plenums, Exposed:
  1. Painted Aluminum, Smooth: 0.020 inch (0.51 mm) thick.
  2. Stainless Steel, Type 304, Smooth 2B Finish: 0.020 inch (0.51 mm) thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
  1. None.
  2. PVC: 20 mils (0.5 mm) thick.
  3. Painted Aluminum, Stucco Embossed: 0.020 inch (0.51 mm) thick.
  4. Stainless Steel, Type 304, Stucco Embossed: 0.020 inch (0.51 mm) thick.
- D. Ducts and Plenums, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
  1. Painted Aluminum, Stucco Embossed: 0.020 inch (0.51 mm) thick.
  2. Stainless Steel, Type 304, Stucco Embossed: 0.020 inch (0.51 mm) thick.
- E. Ducts and Plenums, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
  1. Painted Aluminum, Stucco Embossed with 1-1/4-Inch- (32-mm-) Deep Corrugations: 0.032 inch (0.81 mm) thick.



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2. Stainless Steel, Type 304, Stucco Embossed, with 1-1/4-Inch- (32-mm-) Deep Corrugations: 0.020 inch (0.51 mm) thick.

**END OF SECTION 23 07 13**



## **SECTION 23 09 23.12 - CONTROL DAMPERS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Rectangular control dampers with airfoil blades.
2. Rectangular control dampers with flat blades.
3. Rectangular control dampers with insulated blades.
4. Rectangular control dampers with integral airflow monitoring.
5. Rectangular control dampers with integral airflow control.
6. Round control dampers.
7. Round industrial-duty control dampers.
8. Electric and electronic control-damper actuators.

#### **1.2 DEFINITIONS**

- A. DDC:** Direct digital control.
- B. RMS:** Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- C. Thermal Efficiency Ratio (E):** Comparison of a tested damper's thermal performance against a v-groove blade reference damper. A damper with the same thermal efficiency as the reference damper would have an E value of 0 percent, while a damper that is 4 times as efficient would have an E value of 200 percent.

#### **1.3 ACTION SUBMITTALS**

**A. Product Data:**

1. Rectangular control dampers with airfoil blades.
2. Rectangular control dampers with flat blades.
3. Rectangular control dampers with insulated blades.
4. Rectangular control dampers with integral airflow monitoring.
5. Rectangular control dampers with integral airflow control.
6. Rectangular industrial-duty control dampers.
7. Round control dampers.
8. Round industrial-duty control dampers.
9. Electric and electronic control-damper actuators.

**B. Product Data Submittals:** For each damper and actuator.



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1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for pneumatic signal and main air tubing.

D. Delegated Design Submittals:

1. Schedule and design calculations for control dampers and actuators, including the following:
  - a. Unique designation for each damper/actuator assembly.
  - b. Service/application.
  - c. Damper assembly size.
  - d. Damper assembly weight, including actuator(s).
  - e. Damper and actuator action (modulating or two position).
  - f. Flow at project design and minimum flow conditions.
  - g. Face velocity at project design and minimum airflow conditions.
  - h. Pressure drop across damper at project design and minimum airflow conditions.
  - i. AMCA 500D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
  - j. Maximum close-off pressure.
  - k. Leakage airflow at maximum system pressure differential (fan close-off pressure).
  - l. Damper torque required at worst-case condition for sizing actuator.
  - m. Actuator selection indicating torque provided.
  - n. Actuator fail-safe position on loss of power and loss of signal.
  - o. Remarks listing special requirements.



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1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are indicated and coordinated with each other, using input from installers of the items involved:
1. Product installation location indicated in relationship to room, duct, and equipment.
  2. Size and location of wall access panels for control dampers and actuators installed behind walls.
  3. Size and location of ceiling access panels for control dampers and actuators installed above inaccessible ceilings.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For control dampers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE 62.1 Compliance: Applicable outdoor ventilation requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. Code Compliance: Comply with governing energy code.
- E. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to size products where indicated as delegated design.
- F. Ground Fault: Properly ground products to prevent failing due to ground fault conditions.
- G. Backup Power Source: Serve control-damper actuators from a backup power source where associated with systems and equipment served by a backup power source.
- H. Environmental Conditions: For actuators not available with integral enclosures complying with requirements indicated, house in protective secondary enclosures complying with requirements.



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I. Selection Criteria:

1. Multi-Blade Damper Configuration: As follows unless otherwise indicated on Drawings:
  - a. Two-Position Control: parallel.
  - b. Equipment Isolation Applications: parallel.
  - c. Face and Bypass Applications: Opposed.
  - d. Outdoor/Return Air-Mixing Applications: Opposed.
  - e. All Other Applications: Opposed.
2. Pressure and Temperature: Control dampers suitable for operating conditions encountered by the application and following conditions unless otherwise indicated on Drawings:
  - a. Supply Air:.
  - b. Return Air:.
  - c. Outdoor Air:.
  - d. Mixed Air:.
3. Select dampers with smooth and stable operation throughout full range of operation over varying pressures and temperatures encountered.
4. Sizing: As follows unless otherwise indicated on Drawings
  - a. Modulating Dampers: Select damper size for a pressure drop of percent of fan total static pressure unless otherwise indicated.
  - b. Two-Position Dampers: Full size of duct or equipment connection unless otherwise indicated.

2.2 RECTANGULAR CONTROL DAMPERS WITH AIRFOIL BLADES

A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
  - a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material (aluminum, galvanized steel, stainless steel) as damper frame.
2. Factory install actuator(s) as integral part of damper assembly. Coordinate, with damper manufacturer, field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements.

B. Rectangular Control Dampers with Aluminum Airfoil Blades and Frames:



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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Alan Manufacturing, Inc.](#)
  - b. [Arzel Zoning Technology, Inc.](#)
  - c. [Marshall Stamping.](#)
  - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
2. Source Limitations: Obtain rectangular control dampers, with aluminum airfoil blades and frames, from single manufacturer.
3. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.
4. Performance:
  - a. Leakage:
    - 1) AMCA 511, Class 1A, at 1 in. wg (250 Pa) Differential Static Pressure: Leakage not to exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1 in. wg (250 Pa) differential static pressure when tested in accordance with AMCA 500D.
    - 2) AMCA 511, Class 1, at 4 in. wg (1000 Pa) Differential Static Pressure: Leakage not to exceed 8 cfm/sq. ft. (40.6 L/s per sq. m) against 4 in. wg (1000 Pa) differential static pressure when tested in accordance with AMCA 500D.
  - b. Pressure Drop: 0.05 in. wg (12.5 Pa) at across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
  - c. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/180 of blade length.
  - d. Temperature: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
  - e. Velocity: Up to 4000 fpm (20 m/s).
5. Construction:
  - a. Frame:
    - 1) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, minimum 0.125 inch (3 mm) thick.
    - 2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum 1 inch (25 mm) for attachment to duct flanges, plenum walls, and equipment.
    - 3) Width: Not less than 5 inches (125 mm).
  - b. Blades:
    - 1) Configuration: Parallel or opposed blade configuration as required by application.
    - 2) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch (1.8 mm) thick.



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- 3) Shape: Hollow, airfoil.
- 4) Length: As required by close-off pressure rating, not to exceed 48 inches (1200 mm).
- 5) Width: Not to exceed 6 inches (150 mm).

c. Seals:

- 1) Blades: Replaceable; extruded Santoprene, silicone, or damper manufacturer-offered equivalent, as required by performance requirements. Seals are mechanically attached in extruded blade slots.
- 2) Jambs: Replaceable; stainless steel, compression type or mechanically attached extruded silicone.

d. Axles:

- 1) Diameter: Minimum 0.375 inch (10 mm).
- 2) Material: plated steel.
- 3) Mechanically attached to blades.

e. Bearings:

- 1) Material: Molded acetal stainless steel sleeve, as required by operating conditions, mounted in frame.
- 2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

- 1) Hardware: Plated steel.
- 2) Material: plated steel.
- 3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

- 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
- 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
  - a) Sleeve length not less than 12 inches (300 mm) for dampers without jackshafts and not less than 16 inches (450 mm) for dampers with jackshafts.
  - b) Oversize damper and sleeve for duct connection size plus minimum 4 inches (100 mm).
- 3) Fabricate sleeve and transitions of materials (aluminum, galvanized steel or stainless steel) to match damper frame or adjoining duct.
- 4) Match end connections (flange or sleeve) to field connections.



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h. Additional Corrosion Protection for Corrosive Environments:

- 1) Provide anodized finish, minimum of 0.0007 inch (0.018 mm) thick, for aluminum surfaces in contact with airstream.
- 2) Paint surfaces exposed to airstream with an enamel finish. Prepare surfaces to be painted according to paint manufacturer's instructions.
- 3) Construct axles, damper linkage, and hardware of Type 316L stainless steel.

C. Rectangular Control Dampers with Galvanized-Steel Airfoil Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Alan Manufacturing, Inc.](#)
  - b. [Arzel Zoning Technology, Inc.](#)
  - c. [Marshall Stamping.](#)
  - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
2. Source Limitations: Obtain rectangular control dampers, with galvanized-steel airfoil blades and frames, from single manufacturer.
3. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.
4. Performance:
  - a. Leakage:
    - 1) AMCA 511, Class 1A, at 1 in. wg (250 Pa) Differential Static Pressure: Leakage not to exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1 in. wg (250 Pa) differential static pressure when tested in accordance with AMCA 500D.
    - 2) AMCA 511, Class 1, at 4 in. wg (1000 Pa) Differential Static Pressure: Leakage not to exceed 8 cfm/sq. ft. (40.6 L/s per sq. m) against 4 in. wg (1000 Pa) differential static pressure when tested in accordance with AMCA 500D.
  - b. Pressure Drop: 0.06 in. wg (15 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
  - c. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/180 of blade length.
  - d. Temperature: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
  - e. Velocity: Up to 4000 fpm (20 m/s).
5. Construction:
  - a. Frame:



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- 1) Material: ASTM A653/A653M galvanized steel, minimum 0.06 inch (1.6 mm) thick.
- 2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum 1 inch (25 mm) for attachment to duct flanges, plenum walls, and equipment.
- 3) Width: Not less than 5 inches (125 mm).

b. Blades:

- 1) Configuration: Parallel or opposed blade configuration as required by application.
- 2) Material: ASTM A653/A653M galvanized steel, 0.05 inch (1.3 mm) thick.
- 3) Shape: Hollow, airfoil.
- 4) Length: As required by close-off pressure rating, not to exceed 48 inches (1200 mm).
- 5) Width: Not to exceed 8 inches (200 mm).

c. Seals:

- 1) Blades: Replaceable; extruded silicone, vinyl, or damper manufacturer-offered equivalent, as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
- 2) Jambs: Stainless steel, compression type.

d. Axles:

- 1) Diameter: Minimum 0.375 inch (10 mm).
- 2) Material: Plated steel.
- 3) Mechanically attached to blades.

e. Bearings:

- 1) Material: Molded acetal stainless steel sleeve, as required by operating conditions, mounted in frame.
- 2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

- 1) Hardware: Plated steel.
- 2) Material: Plated steel.
- 3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

- 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.



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- 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
    - a) Sleeve length not less than 12 inches (300 mm) for dampers without jackshafts and not less than 16 inches (450 mm) for dampers with jackshafts.
    - b) Oversize damper and sleeve for duct connection size plus minimum 4 inches (100 mm).
  - 3) Fabricate sleeve and transitions of galvanized steel.
  - 4) Match end connections (flange or sleeve) to field connections.
- h. Additional Corrosion Protection for Corrosive Environments:
- 1) Paint surfaces exposed to airstream with an enamel finish. Prepare surfaces to be painted according to paint manufacturer's instructions.

D. Rectangular Control Dampers with Stainless Steel Airfoil Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Alan Manufacturing, Inc.](#)
  - b. [Arzel Zoning Technology, Inc.](#)
  - c. [Marshall Stamping.](#)
  - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
2. Source Limitations: Obtain rectangular control dampers, with stainless steel airfoil blades and frames, from single manufacturer.
3. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.
4. Performance:
  - a. Leakage:
    - 1) AMCA 511, Class 1A, at 1 in. wg (250 Pa) Differential Static Pressure: Leakage not to exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1 in. wg (250 Pa) differential static pressure when tested in accordance with AMCA 500D.
    - 2) AMCA 511, Class 1, at 4 in. wg (1000 Pa) Differential Static Pressure: Leakage not to exceed 8 cfm/sq. ft. (40.6 L/s per sq. m) against 4 in. wg (1000 Pa) differential static pressure when tested in accordance with AMCA 500D.
  - b. Pressure Drop: 0.06 in. wg (15 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
  - c. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/180 of blade length.



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- d. Temperature: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
- e. Velocity: Up to 4000 fpm (20 m/s).

5. Construction:

a. Frame:

- 1) Material: Type 304 stainless steel, minimum 0.06 inch (1.6 mm) thick.
- 2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum 1 inch (25 mm) for attachment to duct flanges, plenum walls, and equipment.
- 3) Width: Not less than 5 inches (125 mm).

b. Blades:

- 1) Configuration: Parallel or opposed blade configuration as required by application.
- 2) Material: Type 304 stainless steel, 0.05 inch (1.3 mm) thick.
- 3) Shape: Hollow, airfoil.
- 4) Length: As required by close-off pressure rating, not to exceed 48 inches (1200 mm).
- 5) Width: Not to exceed 8 inches (200 mm).

c. Seals:

- 1) Blades: Replaceable; extruded silicone as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
- 2) Jambs: Stainless steel, compression type.

d. Axles:

- 1) Diameter: Minimum 0.375 inch (10 mm).
- 2) Material: Type 303 or 304 stainless steel.
- 3) Mechanically attached to blades.

e. Bearings:

- 1) Material: Molded nylon or stainless steel sleeve, as required by operating conditions, mounted in frame.
- 2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

- 1) Hardware: Stainless steel.
- 2) Material: Type 304 or 316 stainless steel.
- 3) Mounting: Concealed in frame.



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g. Transitions with Sleeve:

- 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
- 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
  - a) Sleeve length not less than 12 inches (300 mm) for dampers without jackshafts and not less than 16 inches (450 mm) for dampers with jackshafts.
  - b) Oversize damper and sleeve for duct connection size plus minimum 4 inches (100 mm).
- 3) Fabricate sleeve and transitions of materials to match damper frame.
- 4) Match end connections (flange or sleeve) to field connections.

## 2.3 RECTANGULAR CONTROL DAMPERS WITH FLAT BLADES

A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
  - a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material (aluminum, galvanized steel, stainless steel) as damper frame.
2. Factory install actuator(s) as integral part of damper assembly. Coordinate, with damper manufacturer, field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements.

B. Rectangular Control Dampers with Aluminum Flat Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Alan Manufacturing, Inc.](#)
  - b. [Arzel Zoning Technology, Inc.](#)
  - c. [Marshall Stamping.](#)
  - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
2. Source Limitations: Obtain rectangular control dampers, with aluminum flat blades and frames, from single manufacturer.
3. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.
4. Performance:



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- a. Leakage:
    - 1) AMCA 511, Class 1, at 1 in. wg (250 Pa) Differential Static Pressure: Leakage not to exceed 3.2 cfm/sq. ft. (16.2 L/s per sq. m) against 1 in. wg (250 Pa) differential static pressure when tested in accordance with AMCA 500D.
  - b. Pressure Drop: 0.08 in. wg (20 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
  - c. Pressure Rating: 2.0 in. wg (500 Pa).
  - d. Temperature: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
  - e. Velocity: Up to 2000 fpm (10 m/s).
5. Construction:
- a. Frame:
    - 1) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, minimum 0.08 inch (2 mm) thick.
    - 2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum 1 inch (25 mm) for attachment to duct flanges, plenum walls and equipment.
    - 3) Width: Not less than 5 inches (125 mm).
  - b. Blades:
    - 1) Configuration: Parallel or opposed blade configuration as required by application.
    - 2) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, 0.125 inch (3 mm) thick.
    - 3) Shape: Single thickness.
    - 4) Length: As required by pressure rating, not to exceed 48 inches (1200 mm).
    - 5) Width: Not to exceed 6 inches (150 mm).
  - c. Seals:
    - 1) Blades: Replaceable; extruded silicone or vinyl, as required by performance requirements. Mechanically attached in extruded blade slots.
    - 2) Jambs: Stainless steel, compression type.
  - d. Axles:
    - 1) Diameter: Minimum 0.5 inch (13 mm).
    - 2) Material: Aluminum or plated steel.
    - 3) Mechanically attached to blades.



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e. Bearings:

- 1) Material: Celcon, polycarbonate or synthetic, mounted in frame.

f. Linkage:

- 1) Hardware: Plated or stainless steel.
- 2) Material: Aluminum or plated steel.
- 3) Mounting: Concealed in frame.

g. Additional Corrosion Protection for Corrosive Environments:

- 1) Provide anodized finish for aluminum surfaces in contact with airstream.

C. Rectangular Control Dampers with Galvanized-Steel Flat Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Alan Manufacturing, Inc.](#)
  - b. [Arzel Zoning Technology, Inc.](#)
  - c. [Marshall Stamping.](#)
  - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
2. Source Limitations: Obtain rectangular control dampers, with galvanized-steel flat blades and frames, from single manufacturer.
3. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.
4. Performance:
  - a. Leakage:
    - 1) AMCA 511, Class II, at 1 in. wg (250 Pa) Differential Static Pressure: Leakage not to exceed 5.4 cfm/sq. ft. (27.4 L/s per sq. m) against 1 in. wg (250 Pa) differential static pressure when tested in accordance with AMCA 500D.
  - b. Pressure Drop: 0.1 in. wg (25 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
  - c. Pressure Rating: 2.0 in. wg (500 Pa).
  - d. Temperature: Minus 20 to plus 185 deg F (Minus 29 to plus 85 deg C).
  - e. Velocity: Up to 2000 fpm (10 m/s).
5. Construction:
  - a. Frame:



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- 1) Material: ASTM A653/A653M galvanized steel, minimum 0.06 inch (1.6 mm) thick.
- 2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum 1 inch (25 mm) for attachment to duct flanges, plenum walls, and equipment.
- 3) Width: Not less than 5 inches (125 mm).

b. Blades:

- 1) Configuration: Parallel or opposed blade configuration as required by application.
- 2) Material: ASTM A653/A653M galvanized steel, 0.06 inch (1.6 mm) thick.
- 3) Shape: Single thickness with bends for reinforcing.
- 4) Length: As required by pressure rating, not to exceed 48 inches (1200 mm).
- 5) Width: Not to exceed 8 inches (200 mm).

c. Seals:

- 1) Blades: Replaceable; extruded silicone, vinyl, or damper manufacturer-offered equivalent, as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
- 2) Jambs: Stainless steel, compression type.

d. Axles:

- 1) Diameter: Minimum 0.375 inch (10 mm).
- 2) Material: Plated steel.
- 3) Mechanically attached to blades.

e. Bearings:

- 1) Material: Molded nylon, or stainless steel sleeve, as required by operating conditions, mounted in frame.
- 2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

- 1) Hardware: Plated steel.
- 2) Material: Plated steel.
- 3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

- 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.



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- 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
    - a) Sleeve length not less than 12 inches (300 mm) for dampers without jackshafts and not less than 16 inches (450 mm) for dampers with jackshafts.
    - b) Oversize damper and sleeve for duct connection size plus minimum 4 inches (100 mm).
  - 3) Fabricate sleeve and transitions of galvanized steel.
  - 4) Match end connections (flange or sleeve) to field connections.
- h. Additional Corrosion Protection for Corrosive Environments:
- 1) Paint surfaces exposed to airstream with an enamel finish. Prepare surfaces to be painted according to paint manufacturer's instructions.

D. Rectangular Control Dampers with Stainless Steel Flat Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Alan Manufacturing, Inc.](#)
  - b. [Arzel Zoning Technology, Inc.](#)
  - c. [Marshall Stamping.](#)
  - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
2. Source Limitations: Obtain rectangular control dampers, with stainless steel flat blades and frames, from single manufacturer.
3. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.
4. Performance:
  - a. Leakage:
    - 1) AMCA 511, Class II, at 1 in. wg (250 Pa) Differential Static Pressure: Leakage not to exceed 5.4 cfm/sq. ft. (27.4 L/s per sq. m) against 1 in. wg (250 Pa) differential static pressure when tested in accordance with AMCA 500D.
  - b. Pressure Drop: 0.1 in. wg (25 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
  - c. Pressure Rating: 2.0 in. wg (500 Pa).
  - d. Temperature: Minus 20 to plus 185 deg F (Minus 29 to plus 85 deg C).
  - e. Velocity: Up to 2000 fpm (10 m/s).
5. Construction:



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a. Frame:

- 1) Material: Type 304 stainless steel, minimum 0.06 inch (1.6 mm) thick.
- 2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum 1 inch (25 mm) for attachment to duct flanges, plenum walls, and equipment.
- 3) Width: Not less than 5 inches (125 mm).

b. Blades:

- 1) Configuration: Parallel or opposed blade configuration as required by application.
- 2) Material: Type 304 stainless steel, 0.06 inch (1.6 mm) thick.
- 3) Shape: Single thickness with bends for reinforcing.
- 4) Length: As required by pressure rating, not to exceed 48 inches (1200 mm).
- 5) Width: Not to exceed 8 inches (200 mm).

c. Seals:

- 1) Blades: Replaceable; extruded silicone, vinyl, or damper manufacturer-offered equivalent, as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
- 2) Jambs: Stainless steel, compression type.

d. Axles:

- 1) Diameter: Minimum 0.375 inch (10 mm).
- 2) Material: Type 304 or 316 stainless steel.
- 3) Mechanically attached to blades.

e. Bearings:

- 1) Material: Molded nylon, or stainless steel sleeve, as required by operating conditions, mounted in frame.
- 2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

- 1) Hardware: Stainless steel.
- 2) Material: Type 304 or 316 stainless steel.
- 3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

- 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.



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- 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
  - a) Sleeve length not less than 12 inches (300 mm) for dampers without jackshafts and not less than 16 inches (450 mm) for dampers with jackshafts.
  - b) Oversize damper and sleeve for duct connection size plus minimum 4 inches (100 mm).
- 3) Fabricate sleeve and transitions of Type 304 stainless steel.
- 4) Match end connections (flange or sleeve) to field connections.

## 2.4 RECTANGULAR CONTROL DAMPERS WITH INSULATED BLADES

### A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
  - a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material (aluminum) as damper frame.
2. Factory install actuator(s) as integral part of damper assembly. Coordinate field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements with damper manufacturer.

### B. Rectangular Control Dampers with Insulated Aluminum Airfoil Blades:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Alan Manufacturing, Inc.](#)
  - b. [Arzel Zoning Technology, Inc.](#)
  - c. [Marshall Stamping.](#)
  - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
2. Source Limitations: Obtain rectangular control dampers, with insulated aluminum airfoil blades, from single manufacturer.
3. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance, air leakage, and thermal performance.
4. Performance:
  - a. Leakage:
    - 1) AMCA 511, Class 1A, at 1 in. wg (250 Pa) Differential Static Pressure: Leakage not to exceed 3 cfm/sq. ft. (15.2 L/s per sq. m)



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- against 1 in. wg (250 Pa) differential static pressure when tested in accordance with AMCA 500D.
- 2) AMCA 511, Class 1, at 4 in. wg (1000 Pa) Differential Static Pressure: Leakage not to exceed 8 cfm/sq. ft. (40.6 L/s per sq. m) against 4 in. wg (1000 Pa) differential static pressure when tested in accordance with AMCA 500D.
- b. Pressure Drop: 0.05 in. wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
  - c. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure, not less than 8.0 in. wg (2000 Pa).
  - d. Temperature: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
  - e. Thermal Performance:
    - 1) R-Value: 2.2 or higher.
    - 2) Thermal Efficiency Ratio (E): 345 or higher when tested in accordance with AMCA 500D.
  - f. Velocity: Up to 4000 fpm (20 m/s).
5. Construction:
- a. Frame:
    - 1) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, minimum 0.08 inch (2 mm) thick.
    - 2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum 1 inch (25 mm) for attachment to duct flanges, plenum walls, and equipment.
    - 3) Width: Not less than 5 inches (125 mm).
  - b. Blades:
    - 1) Configuration: Parallel or opposed blade configuration as required by application.
    - 2) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch (1.8 mm) thick.
    - 3) Shape: Airfoil.
    - 4) Length: As required by close-off pressure rating, not to exceed 48 inches (1200 mm).
    - 5) Width: Not to exceed 6 inches (150 mm).
    - 6) Insulation: Hollow airfoil blade internally insulated with expanded polyurethane foam for thermal performance indicated.
    - 7) Thermal Break: Complete thermal break with blades in full closed position.
  - c. Seals:



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- 1) Blades: Replaceable; extruded EPDM, Santoprene or silicone, or damper manufacturer-offered equivalent, as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
- 2) Jambs: Replaceable; polycarbonate, compression type or mechanically attached extruded silicone.

d. Axles:

- 1) Diameter: Minimum 0.44 inch (11 mm).
- 2) Material: Aluminum or plated steel.
- 3) Mechanically attached to blades.

e. Bearings:

- 1) Material: Molded inner and outer bearings of acetal, as required by operating conditions.
- 2) Mounting: Inner bearing fixed to axle, rotating within an outer bearing inserted in the frame, resulting in no metal-to-metal contact.
- 3) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

- 1) Hardware: Plated steel.
- 2) Material: plated steel.
- 3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

- 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
- 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
  - a) Sleeve length not less than 12 inches (300 mm) for dampers without jackshafts and not less than 16 inches (450 mm) for dampers with jackshafts.
  - b) Oversize damper and sleeve for duct connection size plus minimum 4 inches (100 mm).
- 3) Fabricate sleeve and transitions of materials (aluminum, galvanized steel, or stainless steel) to match damper frame or adjoining duct.
- 4) Match end connections (flange or sleeve) to field connections.

h. Additional Corrosion Protection for Corrosive Environments:

- 1) Provide anodized finish, minimum of 0.0007 inch (0.018 mm) thick, for aluminum surfaces in contact with airstream.



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- 2) Paint surfaces exposed to airstream with an enamel finish. Prepare surfaces to be painted according to paint manufacturer's instructions.
- 3) Construct axles, damper linkage, and hardware of Type 316L stainless steel.

C. Rectangular Control Dampers with Insulated Aluminum Airfoil Blades and Thermal Break Frames:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Alan Manufacturing, Inc.](#)
  - b. [Arzel Zoning Technology, Inc.](#)
  - c. [Marshall Stamping.](#)
  - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
2. Source Limitations: Obtain rectangular control dampers, with insulated aluminum airfoil blades and thermal break, from single manufacturer.
3. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance, air leakage, and thermal performance.
4. Performance:
  - a. Leakage:
    - 1) AMCA 511, Class 1A, at 1 in. wg (250 Pa) Differential Static Pressure: Leakage not to exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1 in. wg (250 Pa) differential static pressure when tested in accordance with AMCA 500D.
    - 2) AMCA 511, Class 1, at 4 in. wg (1000 Pa) Differential Static Pressure: Leakage not to exceed 8 cfm/sq. ft. (40.6 L/s per sq. m) against 4 in. wg (1000 Pa) differential static pressure when tested in accordance with AMCA 500D.
  - b. Pressure Drop: 0.05 in. wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
  - c. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure, not less than 8.0 in. wg (2000 Pa).
  - d. Temperature: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
  - e. Thermal Performance:
    - 1) R-Value: 2.2 or higher.
    - 2) Thermal Efficiency Ratio (E): 345 or higher when tested in accordance with AMCA 500D.
  - f. Velocity: Up to 4000 fpm (20 m/s).
5. Construction:



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a. Frame:

- 1) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, minimum 0.08 inch (2 mm) thick.
- 2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum 1 inch (25 mm) for attachment to duct flanges, plenum walls, and equipment.
- 3) Thermal Break: Continuous extruded pocket at two locations, one on each side of closed damper blade, with polyurethane resin fill to achieve frame with no through metal.
- 4) Width: Not less than 5 inches (125 mm).

b. Blades:

- 1) Configuration: Parallel or opposed blade configuration as required by application.
- 2) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch (1.8 mm) thick.
- 3) Shape: Airfoil.
- 4) Length: As required by close-off pressure rating, not to exceed 48 inches (1200 mm).
- 5) Width: Not to exceed 6 inches (150 mm).
- 6) Insulation: Hollow airfoil blade internally insulated with expanded polyurethane foam for thermal performance indicated.
- 7) Thermal Break: Complete thermal break with blades in full closed position.

c. Seals:

- 1) Blades: Replaceable; extruded EPDM, Santoprene or silicone, or damper manufacturer-offered equivalent, as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
- 2) Jambs: Replaceable; polycarbonate, compression type or mechanically attached extruded silicone.

d. Axles:

- 1) Diameter: Minimum 0.44 inch (11 mm).
- 2) Material: Aluminum or plated steel.
- 3) Mechanically attached to blades.

e. Bearings:

- 1) Material: Molded inner and outer bearings of acetal, as required by operating conditions.
- 2) Mounting: Inner bearing fixed to axle, rotating within an outer bearing inserted in the frame, resulting in no metal-to-metal contact.



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- 3) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

- 1) Hardware: Plated steel.
- 2) Material: plated steel.
- 3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

- 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
- 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
  - a) Sleeve length not less than 12 inches (300 mm) for dampers without jackshafts and not less than 16 inches (450 mm) for dampers with jackshafts.
  - b) Oversize damper and sleeve for duct connection size plus minimum 4 inches (100 mm).
- 3) Fabricate sleeve and transitions of materials (aluminum, galvanized steel, or stainless steel) to match damper frame[ **or adjoining duct**].
- 4) Match end connections (flange or sleeve) to field connections.

h. Additional Corrosion Protection for Corrosive Environments:

- 1) Provide anodized finish, minimum of 0.0007 inch (0.018 mm) thick, for aluminum surfaces in contact with airstream.
- 2) Paint surfaces exposed to airstream with an finish. Prepare surfaces to be painted according to paint manufacturer's instructions.
- 3) Construct axles, damper linkage, and hardware of Type 316L stainless steel.

## 2.5 RECTANGULAR CONTROL DAMPERS WITH INTEGRAL AIRFLOW MONITORING

A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
  - a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material (aluminum) as damper frame.



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2. Factory install actuator(s) as integral part of damper assembly. Coordinate field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements with damper manufacturer.
- B. Rectangular Control Dampers with Aluminum Airfoil Blades and Integral Airflow Monitoring:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [Alan Manufacturing, Inc.](#)
    - b. [Arzel Zoning Technology, Inc.](#)
    - c. [Marshall Stamping.](#)
    - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
  2. Source Limitations: Obtain rectangular control dampers, with aluminum airfoil blades and integral airflow monitoring, from single manufacturer.
  3. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.
  4. Performance:
    - a. Leakage:
      - 1) AMCA 511, Class 1A, at 1 in. wg (250 Pa) Differential Static Pressure: Leakage not to exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1 in. wg (250 Pa) differential static pressure when tested in accordance with AMCA 500D.
      - 2) AMCA 511, Class 1, at 4 in. wg (1000 Pa) Differential Static Pressure: Leakage not to exceed 8 cfm/sq. ft. (40.6 L/s per sq. m) against 4 in. wg (1000 Pa) differential static pressure when tested in accordance with AMCA 500D.
    - b. Pressure Drop (Damper and Airflow Measurement): 0.15 in. wg (37.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
    - c. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/180 of blade length.
    - d. Temperature: Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
    - e. Velocity (Damper Only): Up to 4000 fpm (20 m/s).
  5. Construction:
    - a. Damper Frame:
      - 1) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, minimum 0.125 inch (3 mm) thick.
      - 2) Arrangement: Hat-shaped channel with attachment to factory furnished sleeve.
      - 3) Width: Not less than 5 inches (125 mm).



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b. Damper Blades:

- 1) Configuration: Parallel or opposed blade configuration as required by application.
- 2) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch (1.8 mm) thick.
- 3) Shape: Hollow, airfoil.
- 4) Length: As required by close-off pressure rating, not to exceed 48 inches (1200 mm).
- 5) Width: Not to exceed 6 inches (150 mm).

c. Damper Seals:

- 1) Blades: Replaceable; extruded Santoprene, silicone, or damper manufacturer-offered equivalent, as required by performance requirements. Damper seals are to be mechanically attached in extruded blade slots.
- 2) Jams: Replaceable; stainless steel, compression type or mechanically attached extruded silicone.

d. Axles:

- 1) Diameter: Minimum 0.375 inch (10 mm).
- 2) Material: plated steel.
- 3) Mechanically attached to blades.

e. Bearings:

- 1) Material: Molded acetal stainless steel sleeve, as required by operating conditions, mounted in frame.
- 2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

- 1) Hardware: Plated steel.
- 2) Material: plated steel.
- 3) Mounting: Concealed in frame.

g. Sleeve:

- 1) General: Factory mount damper assembly and airflow measurement assembly in a common sleeve with a continuous-perimeter flanged face to mate to field connection. Coordinate field-mounting requirements for each application.
- 2) Length: Not less than 15 inches (375 mm).
- 3) Material: galvanized steel.
- 4) Thickness:



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- a) Sleeve Face Sizes through 24 inches (600 mm): Minimum 14 gauge (2 mm).
    - b) Sleeves with Larger Face Size: Minimum 12 gauge (2.7 mm).
  - h. Additional Corrosion Protection for Corrosive Environments:
    - 1) Provide anodized finish, minimum of 0.0007 inch (0.018 mm) thick, for aluminum surfaces in contact with airstream.
    - 2) Paint surfaces exposed to airstream with an enamel finish. Prepare surfaces to be painted in accordance with paint manufacturer's instructions.
    - 3) Construct axles, damper linkage, and hardware of Type 316L stainless steel.
6. Pressure Airflow Measurement:
- a. Performance:
    - 1) Accuracy: Within 5 percent of the actual flow rate between the range of minimum to design airflow and velocity. For applications with a large variation in range between the minimum and design airflow, configure the damper sections and flow measurement assemblies as required to comply with the stated accuracy over entire modulating range.
    - 2) Velocity Range: 300 to 2000 fpm (10 m/s).
    - 3) Provide temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.
    - 4) Suitable for operation with untreated and unfiltered air.
  - b. Flow Straightener: Provide a straightening device as part of flow measurement assembly, if required to achieve specified accuracy with installed configuration indicated.
  - c. Flow Sensors: Hollow, ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles with anodized finish.
  - d. Placement: Locate upstream of damper.
  - e. Pressure Transducer: Housed in NEMA 250, Type 4 painted enclosure.
  - f. Remote Output Signal: Zero- to 10 V dc or 4 to 20 mA scaled output signal proportional to flow for remote monitoring of actual airflow.
  - g. Tubing: Factory pipe transducer(s) to low- and high-pressure ports on flow sensors using manufacturer's standard tubing that is protected from damage during shipping and installation.
  - h. Factory Calibration: Factory calibrate each finished assembly before shipment in accordance with application-specific requirements.
7. Thermal Airflow Measurement:
- a. Certification:



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- 1) Listed and labeled in accordance with UL 873 or UL 60730.
- 2) BTL certified in accordance with ASHRAE 135.
- 3) 47 CFR, Ch. 1, Part 15, Subpart B, Class A device.

b. Performance:

- 1) Airflow Accuracy: Within 5 percent of the actual flow rate between the range of minimum to design airflow. For applications with a large variation in range between the minimum and design airflow, configure the damper sections and flow measurement assemblies as required to comply with the stated accuracy over entire modulating range.
- 2) Ambient Operating Humidity Range (Sensors and Transmitters): Zero to 99 percent, noncondensing.
- 3) Temperature Accuracy: Within 0.2 deg F (0.1 deg C) over entire range.
- 4) Velocity Range:.
- 5) Provide temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.
- 6) Suitable for operation in untreated and unfiltered air.

c. Flow Straightener: Provide a straightening device as part of flow measurement assembly , if required to achieve specified accuracy with installed configuration indicated.

d. Sensors:

- 1) Number of sensors determined by manufacturer for application to comply with accuracy requirements indicated.
- 2) Temperature of each sensor assembly velocity weighted and averaged by transmitter before output if temperature sensor has an accuracy worse than 0.1 deg F (0.06 deg C).
- 3) Each sensor with two individually wired, hermetically sealed thermistors.
- 4) Mount thermistors in sensor using a marine-grade, waterproof material.
- 5) Protect thermistor leads, and do not expose to the environment.
- 6) Independently determine airflow rate and temperature at each sensor measurement point.
- 7) Furnish each sensor probe with an integral cable for connection to transmitter.
- 8) Sensor Probe Material: Anodized, extruded Alloy 6063 aluminum tube.
- 9) Probe Assembly Mounting Bracket Material: Plated steel.
- 10) Connection Enclosure: NEMA 250, Type 1 or 4 for indoor applications Type 4 for outdoor applications.

e. Transmitters:

- 1) Microprocessor based.



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- 2) Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.
  - 3) Capable of field configuration and diagnostics using touch interface and digital display.
  - 4) Password-protected programmable settings.
  - 5) Field selectable between IP and SI units for airflow, temperature, and velocity.
  - 6) Power supply, including the following:
    - a) On-off power switch.
    - b) Protection from transients and power surges.
    - c) Circuitry to ensure reset after power disruption, transients, and brownouts.
    - d) Transformer to convert field power source to operating voltage required.
  - 7) Enclosure: NEMA 250, Type 1 or 4 for indoor applications Type 4 for outdoor applications.
  - 8) Remote Signal Interface:
    - a) Linear Analog Signals for Airflow and Temperature: Fuse protected and isolated, field selectable, 0 to 10 V dc or 4 to 20 mA.
    - b) RS-485: BACnet-MS/TP.
    - c) Ethernet: BACnet Ethernet, BACnet-IP.
  - 9) Factory Calibration: Factory calibrate each airflow station at a minimum of 16 airflow rates and three temperatures to standards that are traceable to NIST.
8. Damper Actuator: Electric, modulating actuator with proportional control and position feedback signals; complying with requirements in "Electric and Electronic Control-Damper Actuators" Article.

## 2.6 RECTANGULAR CONTROL DAMPERS WITH INTEGRAL AIRFLOW CONTROL

### A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
  - a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material (aluminum) as damper frame.



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2. Factory install actuator(s) as integral part of damper assembly. Coordinate field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements with damper manufacturer.
- B. Rectangular Control Dampers with Aluminum Airfoil Blades and Integral Airflow Control:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [Alan Manufacturing, Inc.](#)
    - b. [Arzel Zoning Technology, Inc.](#)
    - c. [Marshall Stamping.](#)
    - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
  2. Source Limitations: Obtain rectangular control dampers, with aluminum airfoil blades and integral airflow control, from single manufacturer.
  3. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.
  4. Performance:
    - a. Leakage:
      - 1) AMCA 511, Class 1A, at 1 in. wg (250 Pa) Differential Static Pressure: Leakage not to exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1 in. wg (250 Pa) differential static pressure when tested in accordance with AMCA 500D.
      - 2) AMCA 511, Class 1, at 4 in. wg (1000 Pa) Differential Static Pressure: Leakage not to exceed 8 cfm/sq. ft. (40.6 L/s per sq. m) against 4 in. wg (1000 Pa) differential static pressure when tested in accordance with AMCA 500D.
    - b. Pressure Drop (Damper and Flow Measurement): 0.15 in. wg (37.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
    - c. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/180 of blade length.
    - d. Temperature (Damper and Flow Measurement): Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
    - e. Velocity (Damper Only): Up to 4000 fpm (20 m/s).
  5. Construction:
    - a. Damper Frame:
      - 1) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, minimum 0.125 inch (3 mm) thick.
      - 2) Arrangement: Hat-shaped channel with attachment to factory-furnished sleeve.



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3) Width: Not less than 5 inches (125 mm).

b. Damper Blades:

- 1) Configuration: Parallel or opposed blade configuration as required by application.
- 2) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch (1.8 mm) thick.
- 3) Shape: Hollow, airfoil.
- 4) Length: As required by close-off pressure rating, not to exceed 48 inches (1200 mm).
- 5) Width: Not to exceed 6 inches (150 mm).

c. Damper Seals:

- 1) Blades: Replaceable; extruded Santoprene, silicone, or damper manufacturer-offered equivalent, as required by performance requirements. Mechanically attached in extruded blade slots.
- 2) Jams: Replaceable; stainless steel, compression type or mechanically attached extruded silicone.

d. Axles:

- 1) Diameter: Minimum 0.375 inch (10 mm).
- 2) Material: Plated steel.
- 3) Mechanically attached to blades.

e. Bearings:

- 1) Material: Molded acetal stainless steel sleeve, as required by operating conditions, mounted in frame.
- 2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

- 1) Hardware: Plated steel.
- 2) Material: plated steel.
- 3) Mounting: Concealed in frame.

g. Sleeve:

- 1) General: Factory mount damper assembly and airflow measurement assembly in a common sleeve with a continuous-perimeter flanged face to mate to field connection. Coordinate field-mounting requirements for each application.
- 2) Length: Not less than 15 inches (375 mm).
- 3) Material: galvanized steel or stainless steel to match adjoining duct.
- 4) Thickness:



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- a) Sleeve Face Sizes through 24 inches (600 mm): Minimum 14 gauge (2 mm).
    - b) Sleeves with Larger Face Size: Minimum 12 gauge (2.7 mm).
  - h. Additional Corrosion Protection for Corrosive Environments:
    - 1) Provide anodized finish, minimum of 0.0007 inch (0.018 mm) thick, for aluminum surfaces in contact with airstream.
    - 2) Paint surfaces exposed to airstream with an enamel finish. Prepare surfaces to be painted according to paint manufacturer's instructions.
    - 3) Construct axles, damper linkage, and hardware of Type 316L stainless steel.
6. Pressure Airflow Measurement and Control:
- a. Performance:
    - 1) Accuracy: Within 5 percent of the actual flow rate between the range of minimum to design airflow and velocity. For applications with a large variation in range between the minimum and design airflow, configure the damper sections and flow measurement assemblies as required to comply with the stated accuracy over entire modulating range.
    - 2) Velocity Range: 150 to 2000 fpm (10 m/s).
    - 3) Provide temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.
    - 4) Suitable for operation with untreated and unfiltered air.
  - b. Flow Straightener: Provide a straightening device as part of flow measurement assembly , if required to achieve specified accuracy with installed configuration indicated.
  - c. Flow Sensors: Hollow, ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles with anodized finish.
  - d. Placement: Locate upstream (inlet side) of damper.
  - e. Programmable Controller: Factory calibrated and programmed in nonvolatile memory for application-specific airflow set point(s) and range to control desired airflow. Include controller with the following:
    - 1) On-off power switch.
    - 2) Protection from transients and power surges.
    - 3) Circuitry to ensure reset after power disruption, transients, and brownouts.
  - f. Remote Control and Monitoring Interface:
    - 1) Airflow Measurement: 0 to 10 V dc or 4 to 20 mA scaled output signal proportional to airflow.



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- 2) Airflow Set Point: 0 to 10 V dc or 4 to 20 mA scaled input signal proportional to airflow.
  - 3) Carbon Dioxide Level: 0 to 10 V dc or 4 to 20 mA scaled input signal proportional to carbon dioxide.
  - 4) Damper Actuator Position Feedback: 0 to 10 V dc or 4 to 20 mA scaled output signal.
  - 5) Damper Position Override Command: 0 to 10 V dc or 4 to 20 mA scaled input signal.
  - 6) Set-Point Alarm: Binary signal.
  - g. Remote Control and Monitoring Serial Interface: RS-485, BACnet-MS/TP.
  - h. Terminal Strip: Screw terminals for interface to field wiring.
  - i. Transformer: Rated for not less than 100 V A. Provide transformer with primary and secondary protection and primary disconnecting means. Coordinate requirements with field power connection.
  - j. Tubing: Factory pipe transducer(s) to low- and high-pressure ports on flow sensors using manufacturer's standard tubing that is protected from damage during shipping and installation.
  - k. Control Enclosure: Factory mount controller, transducers, control transformer, terminal strip, and other control components and electronics within NEMA 250, Type 1 or 4 for indoor applications Type 4 for outdoor applications.
  - l. Factory Calibration: Factory calibrate each finished assembly before shipment to the application-specific requirements.
7. Thermal Airflow Measurement and Control:
- a. Certification:
    - 1) Listed and labeled in accordance with UL 873 or UL 60730.
    - 2) BTL certified in accordance with ASHRAE 135.
    - 3) 47 CFR, Ch. 1, Part 15, Subpart B, Class A device.
  - b. Performance:
    - 1) Airflow Accuracy: Within 5 percent of the actual flow rate between the range of minimum to design airflow. For applications with a large variation in range between the minimum and design airflow, configure the damper sections and flow measurement assemblies as required to comply with the stated accuracy over entire modulating range.
    - 2) Ambient Operating Humidity Range (Sensors and Transmitters): Zero to 99 percent, noncondensing.
    - 3) Temperature Accuracy: Within 0.2 deg F (0.1 deg C) over entire range.
    - 4) Velocity Range: 0 to 3000 fpm (15 m/s).
    - 5) Provide temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.
    - 6) Suitable for operation in untreated and unfiltered air.



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c. Sensors:

- 1) Number of sensors determined by manufacturer for application to comply with accuracy requirements indicated.
- 2) Temperature of each sensor assembly velocity weighted and averaged by transmitter before output if temperature sensor has an accuracy worse than 0.1 deg F (0.06 deg C).
- 3) Each sensor with two individually wired, hermetically sealed thermistors.
- 4) Mount thermistors in sensor using a marine-grade, waterproof material.
- 5) Protect thermistor leads, and do not expose to the environment.
- 6) Independently determine airflow rate and temperature at each sensor measurement point.
- 7) Furnish each sensor probe with an integral cable for connection to transmitter.
- 8) Sensor Probe Material: Anodized, extruded Alloy 6063 aluminum tube.
- 9) Probe Assembly-Mounting Brackets Material: Plated steel.
- 10) Connection Enclosure: NEMA 250, Type 1 or 4 for indoor applications Type 4 for outdoor applications.

d. Transmitters:

- 1) Microprocessor based.
- 2) Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.
- 3) Capable of field configuration and diagnostics using touch interface and digital display.
- 4) Password-protected programmable settings.
- 5) Field selectable between IP and SI units for airflow, temperature, and velocity.
- 6) Power supply, including the following:
  - a) On-off power switch.
  - b) Protection from transients and power surges.
  - c) Circuitry to ensure reset after power disruption, transients, and brownouts.
- 7) Enclosure: NEMA 250, Type 1 or 4 for indoor applications Type 4 for outdoor applications.

e. Programmable Controller: Factory calibrated and programmed in nonvolatile memory for application-specific airflow set point(s) and range to control desired airflow. Include controller with the following:

- 1) On-off power switch.
- 2) Protection from transients and power surges.



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- 3) Circuitry to ensure reset after power disruption, transients, and brownouts.
  - 4) Digital display.
  - 5) Capable of field configuration and diagnostics using touch interface and digital display.
- f. Remote Control and Monitoring Interface:
- 1) Airflow Measurement: 0 to 10 V dc or 4 to 20 mA scaled output signal proportional to airflow.
  - 2) Airflow Set Point: 0 to 10 V dc or 4 to 20 mA scaled input signal proportional to airflow.
  - 3) Carbon Dioxide Level: 0 to 10 V dc or 4 to 20 mA scaled input signal proportional to carbon dioxide.
  - 4) Damper Actuator Position Feedback: 0 to 10 V dc or 4 to 20 mA scaled output signal.
  - 5) Damper Position Override Command: 0 to 10 V dc or 4 to 20 mA scaled input signal.
  - 6) Set-Point Alarm: Binary signal.
  - 7) Temperature Measurement: 0 to 10 V dc or 4 to 20 mA scaled output signal proportional to air temperature.
- g. Remote Control and Monitoring Serial Interface: RS-485, BACnet-MS/TP; Ethernet, BACnet Ethernet, or BACnet-IP.
- h. Terminal Strip: Screw terminals for interface to field wiring.
- i. Transformer: Rated for not less than 100 V A. Provide transformer with primary and secondary protection and primary disconnecting means. Coordinate requirements with field power connection.
- j. Control Enclosure: Factory mount controller, control transformer, and terminal strip within NEMA 250, Type 1 or 4 for indoor applications.
- k. Factory Calibration: Factory calibrate each airflow station at a minimum of 16 airflow rates and three temperatures to standards that are traceable to NIST.
8. Damper Actuator: Electric, modulating actuator with proportional control signals; complying with requirements in "Electric and Electronic Control-Damper Actuators" Article.

## 2.7 ROUND CONTROL DAMPERS

### A. General Requirements:

1. Factory install actuator as integral part of damper assembly. Coordinate field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements with damper manufacturer.

### B. Round, Galvanized-Steel Control Dampers with Sleeve End Connections:



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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Alan Manufacturing, Inc.](#)
  - b. [Arzel Zoning Technology, Inc.](#)
  - c. [Marshall Stamping.](#)
  - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
2. Source Limitations: Obtain round, galvanized-steel control dampers with sleeve end connections from single manufacturer.
3. Performance:
  - a. Leakage: Not to exceed 0.15 cfm/in. (0.0028 L/s per mm) of perimeter blade at 4 in. wg (1000 Pa) differential static pressure when tested in accordance with AMCA 500D.
  - b. Pressure Drop: 0.05 in. wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 12-inch (300-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
  - c. Pressure Rating: 4 in. wg (1000 Pa).
  - d. Temperature: Up to 180 deg F (82 deg C).
  - e. Velocity: Up to 3000 fpm (15 m/s).
4. Size Range: 4 to 24 inches (100 to 600 mm).
5. Construction:
  - a. Frame:
    - 1) End Connection: Sleeve-type connection for mating to adjacent ductwork.
    - 2) Length: Minimum 6 inches (150 mm).
    - 3) Material: Galvanized steel, minimum 20 gauge (1.0 mm) thick.
    - 4) Stiffeners: Outward-turned beads positioned approximately 1-1/2 inches (38 mm) inboard of each end.
    - 5) Standoff: Provide 2-inch- (50-mm-) high, sheet metal standoff for mounting actuator to axle while accommodating field-installed duct insulation.
  - b. Blade: Double-thickness circular flat blades sandwiched together and constructed of galvanized steel.
  - c. Blade Seal: EPDM, neoprene or silicone seal fully encompassing blade edge.
  - d. Axle: 0.5-inch- (13-mm-) diameter plated steel, mechanically attached to blade.
  - e. Bearings: Bronze or stainless steel sleeve pressed into frame.

C. Round, Stainless Steel Control Dampers with Sleeve End Connections:



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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Alan Manufacturing, Inc.](#)
  - b. [Arzel Zoning Technology, Inc.](#)
  - c. [Marshall Stamping.](#)
  - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
2. Source Limitations: Obtain round, stainless steel control dampers with sleeve end connections from single manufacturer.
3. Performance:
  - a. Leakage: Not to exceed 0.15 cfm/in. (0.0028 L/s per mm) of perimeter blade at 4 in. wg (1000 Pa) differential static pressure when tested in accordance with AMCA 500D.
  - b. Pressure Drop: 0.05 in. wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 12-inch (300-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
  - c. Pressure Rating: 4 in. wg (1000 Pa).
  - d. Temperature: Up to 180 deg F (82 deg C).
  - e. Velocity: Up to 3000 fpm (15 m/s).
4. Size Range: 4 to 24 inches (100 to 600 mm).
5. Construction:
  - a. Frame:
    - 1) End Connection: Sleeve-type connection for mating to adjacent ductwork.
    - 2) Length: Minimum 6 inches (150 mm).
    - 3) Material: Type 304 stainless steel, minimum 20 gauge (1.0 mm) thick.
    - 4) Stiffeners: Outward-turned beads positioned approximately 1-1/2 inches (38 mm) inboard of each end.
    - 5) Standoff: Provide 2-inch- (50-mm-) high, sheet metal standoff for mounting actuator to axle while accommodating field-installed duct insulation.
  - b. Blade: Double-thickness circular flat blades sandwiched together and constructed of Type 304 stainless steel.
  - c. Blade Seal: EPDM, neoprene or silicone seal fully encompassing blade edge.
  - d. Axle: 0.5-inch- (13-mm-) diameter, Type 304 or 316 stainless steel, mechanically attached to blade.
  - e. Bearings: Bronze or stainless steel sleeve pressed into frame.

D. Round, Galvanized-Steel Control Dampers with Flanged End Connections:



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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Alan Manufacturing, Inc.](#)
  - b. [Arzel Zoning Technology, Inc.](#)
  - c. [Marshall Stamping.](#)
  - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
2. Source Limitations: Obtain round, galvanized-steel control dampers with flanged end connections from single manufacturer.
3. Performance:
  - a. Leakage: Not to exceed 0.15 cfm/in. (0.0028 L/s per mm) of perimeter blade at 4 in. wg (1000 Pa) differential static pressure when tested in accordance with AMCA 500D.
  - b. Pressure Drop: 0.05 in. wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 12-inch (300-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
  - c. Pressure Rating: 4 in. wg (1000 Pa).
  - d. Temperature: Up to 250 deg F (121 deg C).
  - e. Velocity: Up to 2500 fpm (13 m/s).
4. Size Range: 4 to 48 inches (100 to 1200 mm).
5. Construction:
  - a. Frame:
    - 1) Material: Galvanized steel, thickness as follows:
      - a) Sizes through 18 Inches (450 mm) in Diameter: Minimum 16 gauge (1.6 mm) thick.
      - b) Larger Sizes: Minimum 12 gauge (2.8 mm) thick.
    - 2) Flanges:
      - a) Outward-turned flanges with bolt holes on each end of frame for mating to adjacent ductwork.
      - b) Face: Not less than 1-1/2 inches (38 mm).
      - c) Thickness: Minimum 12 gauge (2.8 mm) thick.
    - 3) Length (Flange Face to Face): Not less than 8 inches (200 mm).
    - 4) Standoff: Provide 3-inch- (75-mm-) high, standoff for mounting actuator to axle while accommodating field-installed duct insulation.
  - b. Blade: Reinforced double-thickness circular flat blades sandwiched together or reinforced single-thickness circular flat blades; constructed of galvanized steel.
    - 1) Double-Thickness Blades (Each Side):



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- a) Sizes through 18 Inches (450 mm): Minimum 18 gauge (1.3 mm) thick.
    - b) Larger Sizes: Minimum 16 gauge (1.6 mm) thick.
  - 2) Single-Thickness Blades:
    - a) Sizes through 36 Inches (900 mm): Minimum 14 gauge (2 mm) thick.
    - b) Larger Sizes: Minimum 12 gauge (2.8 mm) thick.
  - c. Blade Stop: Located in airstream; galvanized steel, full-circumference bar or pin.
  - d. Blade Seal: EPDM, neoprene or silicone, mechanically attached to blade and fully encompassing blade edge. For double-thickness blade designs, sandwich seal between blades.
  - e. Axle: Continuous, plated steel, mechanically attached to blade and angle reinforced as required.
    - 1) Blade Diameter through 24 Inches (600 mm): Minimum 1/2-inch (13-mm) axle diameter.
    - 2) Larger Sizes: Minimum 3/4-inch (19-mm) axle diameter.
  - f. Bearings: Bronze or stainless steel sleeve pressed into frame.
- E. Round, Stainless Steel Control Dampers with Flanged End Connections:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [Alan Manufacturing, Inc.](#)
    - b. [Arzel Zoning Technology, Inc.](#)
    - c. [Marshall Stamping.](#)
    - d. [TEXEL-SEIKOW U.S.A., Inc.](#)
  - 2. Source Limitations: Obtain round, stainless steel control dampers with flanged end connections from single manufacturer.
  - 3. Performance:
    - a. Leakage: Not to exceed 0.15 cfm/in. (0.0028 L/s per mm) of perimeter blade at 4 in. wg (1000 Pa) differential static pressure when tested in accordance with AMCA 500D.
    - b. Pressure Drop: 0.05 in. wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 12-inch (300-mm) damper when tested in accordance with AMCA 500D, figure 5.3.
    - c. Pressure Rating: 4 in. wg (1000 Pa).
    - d. Temperature: Up to 250 deg F (121 deg C).
    - e. Velocity: Up to 2500 fpm (13 m/s).
  - 4. Size Range: 4 to 48 inches (100 to 1200 mm).



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5. Construction:

a. Frame:

- 1) Material: Type 304 stainless steel, thickness as follows:
  - a) Sizes through 18 Inches (450 mm) in Diameter: Minimum 16 gauge (1.6 mm) thick.
  - b) Larger Sizes: Minimum 12 gauge (2.8 mm) thick.
- 2) Flanges:
  - a) Outward-turned flanges with bolt holes on each end of frame for mating to adjacent ductwork.
  - b) Face: Not less than 1-1/2 inches (38 mm).
  - c) Thickness: Minimum 12 gauge (2.8 mm) thick.
- 3) Length (Flange Face to Face): Not less than 8 inches (200 mm).
- 4) Standoff: Provide 3-inch- (75-mm-) high, standoff for mounting actuator to axle while accommodating field-installed duct insulation.

b. Blade: Reinforced double-thickness circular flat blades sandwiched together or reinforced single-thickness circular flat blades; constructed of Type 304 stainless steel.

- 1) Double-Thickness Blades (Each Side):
  - a) Sizes through 18 Inches (450 mm): Minimum 18 gauge (1.3 mm) thick.
  - b) Larger Sizes: Minimum 16 gauge (1.6 mm) thick.
- 2) Single-Thickness Blades:
  - a) Sizes through 36 Inches (900 mm): Minimum 14 gauge (2 mm) thick.
  - b) Larger Sizes: Minimum 12 gauge (2.8 mm) thick.

c. Blade Stop: Located in airstream; Type 304 stainless steel, full-circumference bar or pin.

d. Blade Seal: EPDM, neoprene or silicone, mechanically attached to blade and fully encompassing blade edge. For double-thickness blade designs, sandwich seal between blades.

e. Axle: Continuous, Type 304 stainless steel, mechanically attached to blade and angle reinforced as required.

- 1) Blade diameter through 24 Inches (600 mm): Minimum 1/2-inch (13-mm) axle diameter.
- 2) Larger Sizes: Minimum 3/4-inch (19-mm) axle diameter.



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- f. Bearings: Stainless steel sleeve pressed into frame.

## 2.8 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

- A. Select actuators to operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.
- B. Select actuators with sufficient power and torque to close off against the maximum system pressures encountered. Actuators are to be sized to close off against the fan shutoff pressure as a minimum requirement.
- C. The total damper area operated by an actuator is not to exceed 80 percent of manufacturer's maximum area rating.
- D. Provide one actuator for each damper assembly where possible. Operate multiple actuators required to drive a single damper assembly in unison.
- E. Avoid the use of excessively oversized actuators, which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.
- F. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.
- G. Provide mounting hardware and linkages for connecting actuator to damper.
- H. Select actuators to fail-safe in desired position in the event of a power and signal failure.

## 2.9 ELECTRIC AND ELECTRONIC CONTROL-DAMPER ACTUATORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - 1. [Alan Manufacturing, Inc.](#)
  - 2. [Arzel Zoning Technology, Inc.](#)
  - 3. [Marshall Stamping.](#)
  - 4. [TEXEL-SEIKOW U.S.A., Inc.](#)
- B. Source Limitations: Obtain electric and electronic control-damper actuators from single manufacturer.
- C. Type: Motor operated, with or without gears, electric and electronic.
- D. Voltage:



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1. Voltage selection is delegated to professional designing control system.
  2. Actuator to deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
  3. Actuator to function properly within a range of 85 to 120 percent of nameplate voltage.
- E. Construction:
1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed-steel enclosures.
  2. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains are to be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
  3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
- F. Local Field Adjustment: Make spring-return actuators easily switchable from fail-safe open to fail-safe closed in the field without replacement.
- G. Local Manual Override: Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.
- H. Two-Position Actuators: Single direction, spring return or reversing type.
- I. Modulating Actuators:
1. Capable of stopping at all points across full range, and starting in either direction from any point in range.
  2. Control Input Signal:
    - a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input remains in last position.
    - b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for 0 to 10 V dc and 4 to 20 mA signals.
    - c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to a pulse duration (length) of signal from a dry-contact closure, triac sink, or source controller.
    - d. Programmable Multifunction:
      - 1) Control input, position feedback, and running time are to be factory or field programmable.
      - 2) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
      - 3) Service data, including at a minimum, number of hours powered and number of hours in motion.



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J. Position Feedback:

1. Equip two-position actuators with limit switches or other positive means of a position indication signal for remote monitoring of open and close position.
2. Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

K. Fail-Safe:

1. Where indicated, provide actuator to fail-safe to an end position.
2. Internal spring-return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other nonmechanical forms of fail-safe operation are acceptable only where uniquely indicated.

L. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

M. Damper Attachment:

1. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
2. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and setscrew method of attachment is acceptable only if provided with at least two points of attachment.

N. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F (minus 29 to plus 49 deg C).
2. Humidity: Suitable for humidity range encountered by application; minimum operating range is to be from 5 to 95 percent relative humidity, noncondensing.

O. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 for outdoor and unprotected applications.
4. NEMA 250, Type 9 for hazardous applications requiring explosion-proof construction.
5. Provide actuator enclosure with a heater and controller where required by application.



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P. Stroke Time:

1. Select operating stroke time to be compatible with equipment and system operation, and as follows.
  - a. Operate damper from fully closed to fully open position within 30 seconds.
  - b. Operate damper from fully open to fully closed position within 30 seconds.
  - c. Move damper to fail-safe position within 30 seconds.
2. For actuators operating in smoke-control and other life-safety systems, comply with governing code and NFPA requirements.

Q. Sound: Where actuators are located in tenant-occupied rooms with a room sound-level criteria of NC-35 or lower, comply with the following sound levels:

1. Spring Return: 45 dBA.
2. Nonspring Return: 45 dBA.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 CONTROL-DAMPER APPLICATIONS

- A. Select from damper types indicated to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
- B. Rectangular Control-Damper Applications:
  1. Exhaust Air: Rectangular dampers with aluminum airfoil blades; maximum air pressure and 2,000 fpm maximum air velocity.
  2. Outdoor Air: Rectangular dampers with aluminum airfoil blades; maximum air pressure and 2,000 fpm maximum air velocity.
  3. Return Air: Rectangular dampers with aluminum airfoil blades; maximum air pressure and 1,500 fpm maximum air velocity.



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4. Supply Air: Rectangular dampers with aluminum airfoil blades; maximum air pressure and 2,000 fpm maximum air velocity.

C. Rectangular Control Dampers with Insulated Blade Applications:

1. Exhaust Air: Rectangular dampers with aluminum airfoil blades; maximum air pressure and 2,000 fpm maximum air velocity.
2. Outdoor Air: Rectangular dampers with aluminum airfoil blades; maximum air pressure and 2,000 fpm maximum air velocity.
3. Return Air: Rectangular dampers with aluminum airfoil blades; maximum air pressure and 1,500 fpm maximum air velocity.
4. Supply Air: Rectangular dampers with aluminum airfoil blades; maximum air pressure and 2,000 fpm maximum air velocity.

D. Rectangular Control Dampers with Integral Airflow Applications:

1. Applications with Airflow Measurement: Rectangular dampers with aluminum airfoil blades and integral airflow measurement using **pressure** sensing.
2. Applications with Airflow Control: Rectangular dampers with aluminum airfoil blades and integral airflow control using **pressure** sensing.

E. Round Control-Damper Applications:

1. Exhaust Air: Round galvanized steel dampers, sleeve ends; maximum air pressure and 2,000 fpm maximum air velocity.
2. Outdoor Air: Round galvanized-steel dampers, sleeve ends; maximum air pressure and 2,000 fpm maximum air velocity.
3. Return Air: Round galvanized-steel dampers, sleeve ends; maximum air pressure and 1,500 fpm maximum air velocity.
4. Supply Air: Round galvanized-steel dampers, sleeve ends; maximum air pressure and 2,000 fpm maximum air velocity.

### 3.3 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy most stringent requirements indicated.
- B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a seismic, wind, or others forces common to the application.
- C. Provide ceiling, floor, roof, and wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- D. Seal penetrations made in fire-rated and acoustically rated assemblies.



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E. Fastening Hardware:

1. Wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

G. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:
  - a. Laboratory exhaust airstreams.
  - b. Process exhaust airstreams.
3. Use Type 316 stainless steel tubing and fittings when in contact with a corrosive environment.
4. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
5. Where actuators are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

### 3.4 CONTROL DAMPERS

A. Install smooth transitions, not exceeding 30 degrees, to dampers larger or smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

B. Clearance:

1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
2. Install dampers with at least 24 inches (600 mm) of clear space on sides of dampers requiring service access unless more space is recommended by manufacturer. Provide code required clearances as applicable.

C. Service Access:



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1. Install dampers and actuators to be accessible for visual inspection and service.
  2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 23 33 00 "Air Duct Accessories."
- D. Install dampers straight and true, level in all planes, and square in all dimensions.
- E. Install supplementary structural reinforcement for large multiple-section dampers if factory-furnished support alone cannot handle loading.
- F. Attach field-installed actuator(s) to damper drive shaft.
- G. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

### 3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with damper identification on damper and on face of ceiling where damper is concealed above ceiling.

### 3.6 ELECTRICAL CONNECTIONS

- A. Install electrical power to field-mounted control devices requiring electrical power.
- B. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 23 "Control-Voltage Electrical Power Cables."
- C. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- D. Furnish and install raceways. Comply with requirements in Section 26 05 33.13 "Conduits for Electrical Systems."
- E. Furnish and install circuit breakers. Comply with requirements in Section 26 28 16 "Enclosed Switches and Circuit Breakers."
- F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.



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1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

### 3.7 CONTROL CONNECTIONS

- A. Install control signal wiring to field-mounted control devices.
- B. Connect control signal wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."
- C. Furnish and install raceways. Comply with requirements in Section 26 05 33.13 "Conduits for Electrical Systems."

### 3.8 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

### 3.9 STARTUP

- A. Control-Damper Checkout:
  1. Check installed products before continuity tests, leak tests, and calibration.
  2. Check dampers for proper location and accessibility.
  3. Verify that control dampers are installed correctly for flow direction.
  4. Verify that proper blade alignment, either parallel or opposed, has been provided.
  5. Verify that damper frame attachment is properly secured and sealed.
  6. Verify that damper actuator and damper linkage attachment are secure.
  7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
  8. Verify that damper blade travel is smooth and unobstructed throughout operating range.

### 3.10 ADJUSTMENT, CALIBRATION, AND TESTING

- A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
- B. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressure.



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- C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
- D. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

**END OF SECTION 23 09 23.12**



## **SECTION 230923.14 - FLOW INSTRUMENTS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Airflow measurement stations and sensors.
2. Airflow switches.
3. Airflow transmitters.

#### **1.2 DEFINITIONS**

- A. Ethernet: Local area network based on IEEE 802.3 standards.
- B. FEP: Fluorinated ethylene propylene.
- C. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.
- D. PEEK: Polyetheretherketone.
- E. PTFE: Polytetrafluoroethylene.
- F. PPS: Polyphenylene sulfide.
- G. RS-485: A TIA standard for multipoint communications using two twisted pairs.
- H. RTD: Resistance temperature detector.
- I. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

#### **1.3 ACTION SUBMITTALS**

**A. Product Data:**

1. Airflow measurement stations and sensors.
2. Airflow switches.



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3. Airflow transmitters.
4. Liquid flow meters.

B. Product Data Submittals: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.
5. Product certificates.

C. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

D. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for air and process signal tubing.
5. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

E. Delegated Design Submittal:

1. Schedule and design calculations for flow instruments, including the following.
  - a. Flow at Project design and minimum flow conditions.
  - b. Pressure drop at Project design and minimum flow conditions.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each product requiring a certificate.

B. Product Test Reports: Tests performed by manufacturer and witnessed by a qualified testing agency.

1. Airflow measurement stations and sensors.
2. Airflow switches.



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- 3.     Airflow transmitters.

#### 1.5     CLOSEOUT SUBMITTALS

- A.     Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

#### 1.6     MAINTENANCE MATERIAL SUBMITTALS

- A.     Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B.     Provide parts, as indicated by manufacturer's recommended parts list, for product operation during one -year period following warranty period.

### PART 2 - PRODUCTS

#### 2.1     PERFORMANCE REQUIREMENTS

- A.     Delegated Design: Select and size products to achieve specified performance requirements.
- B.     Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

#### 2.2     GENERAL REQUIREMENTS FOR FLOW INSTRUMENTS

- A.     Air sensors and transmitters are to have an extended range of 10 percent above Project design flow and 10 percent below minimum Project flow to signal abnormal flow conditions and to provide flexibility for changes in operation.
- B.     Source Limitations: For flow instruments, obtain products from single source from single manufacturer.

#### 2.3     AIRFLOW MEASUREMENT STATIONS AND SENSORS

- A.     Performance Requirements:
  - 1.     Adjustable for changes in system operational parameters.
  - 2.     Airflow Sensor and Transmitter Range: Extended range of 10 percent above Project design flow and 10 percent below minimum Project flow to signal abnormal flow conditions.



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3. Manufacturer is to certify that each flow instrument indicated complies with specified performance requirements and characteristics.

- a. Product certificates are required.

B. Thermal Airflow Measurement Stations:

1. Common Performance Requirements:

- a. Provide stations that are adjustable for changes in system operational parameters.
  - b. Manufacturer is to certify that each flow instrument indicated complies with specified performance requirements and characteristics.
  - c. Thermal airflow stations with one or more sensor nodes mounted in a probe, and a remotely mounted microprocessor-based transmitter at each measurement location.
  - d. Sensor Nodes: One self-heated and one zero-power bead-in-glass thermistor, using the principle of thermal dispersion.
  - e. Airflow Rate and Temperature of Each Sensor: Equally weighted and averaged by the transmitter prior to output.
  - f. Sensor-Node and Probe Assemblies:

- 1) Sensor-Node Construction: Two bead-in-glass, hermetically sealed thermistors potted in a marine-grade waterproof epoxy with sensor housings constructed of glass-filled polypropylene. Construct with only the thermistor located within the sensing node and all other electronic components outside the airstream. Epoxy- or glass-encapsulated chip thermistors or devices with exposed leads are not allowed. Devices that use epoxy- or glass-encapsulated chip thermistors, or electronics in the airstream, are unacceptable. Devices with exposed leads are unacceptable.
    - 2) Store sensor-node airflow and temperature calibration data in a serial memory chip, in the cable connecting plug. Stored data does not require matching or adjustments to the transmitter in the field.
    - 3) Sensing-Node Temperature Accuracy: Within 0.15 deg F (0.08 deg C) over an operating range of minus 20 to plus 160 deg F (minus 28.9 to plus 71.1 deg C) and humidity range of 0 to 100 percent RH.
    - 4) Sensor-Probe Mounting Bracket Construction: Type 304 stainless steel.
    - 5) Internal Probe Wiring: Kynar-coated copper between the connecting cable and sensor nodes. PVC-jacketed wiring is unacceptable.
    - 6) Internal Probe Wiring Connections: Solder joints and spot welds, sealed and protected from the elements, so that direct exposure to water will not affect instrument operation. Connectors within the probe, of any type, are unacceptable. Printed circuit boards within the probe are unacceptable.
    - 7) Sensor-Probe Jacket: Integral, FEP jacket, plenum-rated CMP/CL2P, UL/cUL-listed cable, rated for exposures from minus 67 to plus 392



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deg F (minus 55 to plus 200 deg C), and for continuous and direct UV exposure. Plenum-rated PVC jacket cables are unacceptable.

- 8) Sensor-Probe Cable Connector Plug: Gold-plated pins for connection to the transmitter.

g. Transmitter Features and Functions:

- 1) High and/or low airflow alarm with user-defined set point and percent of set-point tolerance.
- 2) Manual or automatic alarm reset, and low-limit cutoff value may be selected to disable the alarm.
- 3) Alarm delay function, field defined.
- 4) Sensor-node malfunction via the system status alarm and ignore the sensor node that is in a fault condition.
- 5) Field configuration, diagnostics, and field output adjustment wizard that allow for a one- or two-point field adjustment to factory calibration for installations that require adjustment.
- 6) Automatic reset after power disruption, transients, and brown-outs through a watchdog timer circuit.
- 7) Operating temperature range of minus 20 to plus 120 deg F (minus 28.9 to plus 48.9 deg C) and humidity range of 5 to 95 percent RH.
- 8) Electrical Power Requirement: 24 V ac (between 22.8 and 26.4 V ac under load) at 20 VA maximum, using a switching power supply that is overcurrent and overvoltage protected.
- 9) Printed Circuit Board Interconnects: Gold-plated edge fingers, receptacle plug pins, and printed circuit board test points.
- 10) Printed Circuit Boards: Electroless nickel immersion gold (ENIG) plated.
- 11) Integrated Circuitry: Temperature-rated, industrial-grade. Commercial-grade integrated circuitry is not acceptable.
- 12) Integration Buffers: Separate integration buffers for display of airflow output, airflow signal output (analog and network), and individual sensor output (IR-interface).

2. For Air-Ducted/Plenum:

- a. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
  - 1) [Air Monitor Corp.](#)
  - 2) [Azbil North America, Inc.](#)
- b. Airflow Station Performance:
  - 1) Independent processing of up to 16 separately wired sensor-node assemblies.
  - 2) Accuracy: Within 3 percent of reading for ducted applications, and within 5 percent of reading for non-ducted applications, when installed in accordance with manufacturer's recommended placement



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guidelines. Include the combined uncertainty of the sensor nodes and transmitter. For devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter, demonstrate compliance with the accuracy requirement over the entire operating range.

c. Sensor-Node and Probe Assemblies:

- 1) Performance rated and tested with a 100 percent survival rate in a 30-day saltwater and acid vapor test with written independent laboratory results.
- 2) Sensor-Node Calibration: Individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard.
  - a) Accuracy: Within 2 percent of reading over the entire calibrated airflow range of 0 to 5000 fpm (0 to 25.4 m/s).
  - b) Individually calibrate thermistor at a minimum of three temperatures to NIST-traceable temperature standards.
- 3) Provide the number of independent sensor nodes as follows:
  - a) For Duct/Plenum Area up to 0.5 sq. ft. (0.046 sq. m): One.
  - b) For Duct/Plenum Area Greater Than 0.5 through 1.0 sq. ft. (0.046 through 0.092 sq. m): Two.
  - c) For Duct/Plenum Area Greater Than 2.0 through 4.0 sq. ft. (0.186 through 0.372 sq. m): Six.
  - d) For Duct/Plenum Area Greater Than 4.0 through 8.0 sq. ft. (0.372 through 0.743 sq. m): Eight.
  - e) For Duct/Plenum Area Greater Than 8.0 through 12.0 sq. ft. (0.743 through 1.11 sq. m): 12.
  - f) For Duct/Plenum Area Greater Than 12.0 through 14.0 sq. ft. (1.11 through 1.30 sq. m): 14.
  - g) For Duct/Plenum Area Greater Than 14.0 sq. ft. (1.30 sq. m): 16.
- 4) For an aspect ratio of 1.5 or less, and an area of 25 sq. ft. (2.32 sq. m) or greater, four probes are required.
- 5) Sensor-Probe Construction: Gold-anodized, 6063 aluminum alloy tube, with each sensor probe containing one or more independently wired sensing nodes.

d. Transmitter:

- 1) Transmitter determines the average airflow rate and temperature of connected sensor nodes in an array for a single location.
- 2) User Interface: 16-character, alpha-numeric, LCD display, with two field-selectable analog output signals and network output capability. Provide one of the following transmitter configurations:



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- a) Model GTC116 Transmitter: Two field-selectable 0-to 10-V dc, or 4- to 20-mA, scalable, isolated, overcurrent protected analog output signals. The first output (AO1) provides the total airflow rate. The second output (AO2) is field configurable for temperature or low and/or high airflow set-point (user-defined) or system status alarm. The RS-485 (BACnet MS/TP, or Modbus RTU) network connection provides the average airflow rate, temperature, high and/or low airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures. The transmitter is to be provided with a Bluetooth low-energy interface card capable of transmitting all transmitter setup parameters, diagnostics, average airflow, and temperature of the device and the airflow and temperature of each sensor node. Software capable of capturing and displaying this transmission will be available via download to Android or iOS phone or tablet. Software is to allow for setup parameters, airflow, temperature, and diagnostic data to be saved on the phone or be emailed.
  - b) Model GTM116 Transmitter: Two field-selectable 0- to 10-V dc, scalable, isolated, and overcurrent protected analog output signals. The first output (AO1) provides the total airflow rate. The second output (AO2) is field configurable for temperature or low and/or high airflow set-point (user-defined) or system status alarm. The Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection provides the average airflow rate, temperature, high and/or low airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures. The transmitter is to be provided with a Bluetooth low-energy interface card capable of transmitting all transmitter setup parameters, diagnostics, average airflow, and temperature of the device and the airflow and temperature of each sensor node. Software capable of capturing and displaying this transmission will be available via download to Android or iOS phone or tablet. Software is to allow for setup parameters, airflow, temperature, and diagnostic data to be saved on the phone or be emailed.
3. For Air Terminal Units:
- a. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
    - 1) [Air Monitor Corp.](#)
    - 2) [Azbil North America, Inc.](#)
  - b. Airflow Station Performance:



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- 1) Independent processing of up to two separately wired sensor-node assemblies.
- 2) Accuracy: Within 3 percent of reading when installed in accordance with manufacturer's recommended placement guidelines. Include the combined uncertainty of the sensor nodes and transmitter. For devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter, demonstrate compliance with the accuracy requirement over the entire operating range.

c. Sensor-Node and Probe Assemblies:

- 1) Sensor-Node Calibration:
  - a) Individually calibrated at a minimum of seven calibration points to NIST-traceable volumetric standards from 0 to 3000 fpm (0 to 15.2 m/s).
  - b) Individually calibrate thermistor at a minimum of three temperatures to NIST-traceable temperature standards.
- 2) Provide the number of independent sensor nodes as follows:
  - a) For a Duct Diameter of 4 Inches (102 mm): One.
  - b) For Duct Diameters 5 through 16 Inches (127 through 406 mm): Two.
- 3) Sensor-Probe Construction: Mill-finish, 6063 aluminum alloy tube, with each sensor probe containing one or more independently wired sensing nodes.

d. Transmitter:

- 1) Transmitter determines the average airflow rate and temperature of all connected sensor nodes in an array for a single location.
- 2) User Interface: An alpha-numeric, LCD display, with two field-selectable analog output signals or one isolated RS-485 (BACnet MS/TP or Modbus RTU) field-selectable network connection.
- 3) Model EF-A Transmitter, Analog Capability: Two field-selectable 0- to 10-V dc, scalable analog output signals. The first output (AO1) provides the total airflow rate. The second output (AO2) is field configurable for temperature or low and/or high airflow set-point (user-defined) or system status alarm.
- 4) Model EF-N Transmitter, Network Communications: The RS-485 (BACnet MS/TP or Modbus RTU) network connection provides the average airflow rate, temperature, high and/or low airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures.
- 5) Contact Closure Relay: One dry contact relay with onboard jumper to drive a remote LED, rated for no less than 30 V dc or 24 V ac at 3 A



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maximum. User configurable as normally open or normally closed during set up.

4. For Packaged HVAC Units, 12.5 Tons (44.0 kW) or Smaller:
  - a. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
    - 1) [Air Monitor Corp.](#)
    - 2) [Azbil North America, Inc.](#)
  - b. Airflow Station Performance:
    - 1) Independent processing of up to two separately wired sensor-node assemblies.
    - 2) Accuracy: Within 10 percent of reading when installed in accordance with manufacturer's recommended placement guidelines. Include the combined uncertainty of the sensor nodes and transmitter. For devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter, demonstrate compliance with the accuracy requirement over the entire operating range.
  - c. Sensor-Node and Probe Assemblies:
    - 1) Sensor-Node Internal Wiring Connections: Sealed and protected from the elements and suitable for direct exposure to water. Devices with exposed leads are unacceptable.
    - 2) Sensor-Node Calibration:
      - a) Individually calibrated at a minimum of seven calibration points to NIST-traceable airflow standards from 0 to 3000 fpm (0 to 15.2 m/s).
      - b) Individually calibrate thermistor at a minimum of three temperatures to NIST-traceable temperature standards.
    - 3) Provide the number of independent sensor nodes as follows:
      - a) For a Duct Diameter of 4 Inches (102 mm): One.
      - b) For Duct Diameters 5 through 16 Inches (127 through 406 mm): Two.
    - 4) Sensor-Probe Construction: Mill-finish, 6063 aluminum alloy tube, with each sensor probe containing one or more independently wired sensing nodes.
  - d. Transmitter:
    - 1) Transmitter determines the average airflow rate and temperature of all connected sensor nodes in an array for a single location.



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- 2) User Interface: An alpha-numeric, LCD display, with two field-selectable analog output signals or one isolated RS-485 (BACnet MS/TP or Modbus RTU) field-selectable network connection.
  - 3) Model EF-A Transmitter, Analog Capability: Two field-selectable 0- to 10-V dc, scalable analog output signals. The first output (AO1) provides the total airflow rate. The second output (AO2) is field configurable for temperature or low and/or high airflow set-point (user-defined) or system status alarm.
  - 4) Model EF-N Transmitter, Network Communications: RS-485 (BACnet MS/TP or Modbus RTU) network connection to provide average airflow rate, temperature, high and/or low airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures.
  - 5) Contact Closure Relay: One dry contact relay with onboard jumper to drive a remote LED, rated for no less than 30 V dc or 24 V ac at 3 A maximum. User configurable as normally open or normally closed during set up.
5. For Directional Airflow:
- a. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
    - 1) [Air Monitor Corp.](#)
    - 2) [Azbil North America, Inc.](#)
  - b. Bi-directional airflow measurement station with temperature output and integral airflow alarming to determine the exfiltration or infiltration airflow rate, and its direction and temperature at each measurement location.
  - c. Bi-directional airflow, or equivalent differential pressure data, is provided to the BAS, with system status indication, configurable airflow alarm, and internal diagnostics routine.
  - d. Sensor-Node Calibration:
    - 1) Individually calibrated at a minimum of nine calibration points to NIST-traceable volumetric standards from minus 3000 to plus 3000 fpm (minus 15.2 to plus 15.2 m/s).
    - 2) Individually calibrate thermistor at a minimum of three temperatures to NIST-traceable temperature standards.
    - 3) Probe to Transmitter Cables: Integral, FEP jacket, plenum-rated CMP/CL2P, UL/cUL-listed cable, rated for exposures from minus 67 to plus 392 deg F (minus 55 to plus 200 deg C), and UV tolerant, with terminal plug for connection to the remotely mounted transmitter.
  - e. Transmitter:
    - 1) Transmitter determines the average airflow rate and temperature of all connected sensor nodes in an array for a single location.



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- 2) User Interface: An alpha-numeric, LCD display, with two field-selectable analog output signals or one isolated RS-485 (BACnet MS/TP or Modbus RTU) field-selectable network connection.
  - 3) Model EF-A Transmitter, Analog Capability: Two field-selectable 0- to 10-V dc, scalable and protected analog output signals. The first output (AO1) provides the total airflow rate. The second output (AO2) is field configurable for temperature low and/or high airflow set-point alarm (user-defined) or system status alarm.
  - 4) Model EF-N Transmitter, Network Communications: The RS-485 (BACnet MS/TP or Modbus RTU) network connection provides the average airflow rate, temperature, high and/or low airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures.
  - 5) Contact Closure Relay: One dry contact relay with onboard jumper to drive a remote LED, rated for no less than 30 V dc or 24 V ac at 3 A maximum. User configurable as normally open or normally closed during set up.
6. For Combination Control Damper and Airflow Station - Equal Area Method Distribution Pattern:
- a. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
    - 1) [Air Monitor Corp.](#)
    - 2) [Azbil North America, Inc.](#)
  - b. Thermal airflow station and integral damper with two or more sensor nodes mounted in a probe, and a remotely mounted microprocessor-based transmitter at each measurement location. Sensor-node distribution pattern to be based on equal area method.
  - c. Airflow Station Performance:
    - 1) Independent processing of up to 16 separately wired sensor-node assemblies.
    - 2) Accuracy: Within 3 percent of reading for ducted applications, and within 5 percent of reading for non-ducted applications, when installed in accordance with manufacturer's recommended placement guidelines. Include the combined uncertainty of the sensor nodes and transmitter. For devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter, demonstrate compliance with the accuracy requirement over the entire operating range.
  - d. Sensor-Node and Probe Assemblies:
    - 1) Performance rated and tested with a 100 percent survival rate in a 30-day saltwater and acid vapor test with written independent laboratory test results.



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- 2) Sensor-Node Calibration: Individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard.
  - a) Accuracy: Within 2 percent of reading over the entire calibrated airflow range of 0 to 5000 fpm (0 to 25.4 m/s).
  - b) Individually calibrate thermistor at a minimum of three temperatures to NIST-traceable temperature standards.
- 3) Provide the number of independent sensor nodes as follows:
  - a) For Damper Area up to 1.0 sq. ft. (0.092 sq. m): Two.
  - b) For Duct/Plenum Area Greater Than 1.0 through 4.0 sq. ft. (0.092 through 0.372 sq. m): Four.
  - c) For Duct/Plenum Area Greater Than 4.0 through 8.0 sq. ft. (0.372 through 0.743 sq. m): Six.
  - d) For Duct/Plenum Area Greater Than 8.0 through 12.0 sq. ft. (0.743 through 1.11 sq. m): Eight.
  - e) For Duct/Plenum Area Greater Than 12.0 through 16.0 sq. ft. (1.11 through 1.49 sq. m): 12.
  - f) For Duct/Plenum Area Greater Than 16.0 sq. ft. (1.49 sq. m): 16.
- 4) Sensor Probe Construction: Gold-anodized, 6063 aluminum alloy tube with each sensor probe containing one or more independently wired sensing nodes.

e. Transmitter:

- 1) Transmitter determines the average airflow rate and temperature of connected sensor nodes in an array for a single location.
- 2) User Interface: 16-character, alpha-numeric, LCD display, with two field-selectable analog output signals and network output capability. Provide one of the following transmitter configurations:
  - a) Model GTC116 Transmitter: Two field-selectable 0- to 10-V dc, or 4- to 20-mA, scalable, isolated, overcurrent protected analog output signals and network output capability. The first output (AO1) provides the total airflow rate. The second output (AO2) is field configurable for temperature or low and/or high airflow set-point (user-defined) or system status alarm. The RS-485 (BACnet MS/TP, or Modbus RTU) network connection provides the average airflow rate, temperature, high and/or low airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures. The transmitter is to be provided with a Bluetooth low-energy interface card capable of transmitting all transmitter setup parameters, diagnostics, average airflow, and temperature of the device and the airflow and temperature of each sensor



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node. Software capable of capturing and displaying this transmission will be available via download to Android or iOS phone or tablet. Software is to allow for setup parameters, airflow, temperature, and diagnostic data to be saved on the phone or be emailed.

- 3) Model GTM116 Transmitter: Two field-selectable 0- to 10-V dc, or 4- to 20-mA, scalable, isolated, and overcurrent protected analog output signals and network output capability. The first output (AO1) provides the total airflow rate. The second output (AO2) is field configurable for temperature or low and/or high airflow set-point (user-defined) or system status alarm. The Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection provides the average airflow rate, temperature, high and/or low airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures. The transmitter is to be provided with a Bluetooth low-energy interface card capable of transmitting all transmitter setup parameters, diagnostics, average airflow, and temperature of the device and the airflow and temperature of each sensor node. Software capable of capturing and displaying this transmission will be available via download to Android or iOS phone or tablet. Software is to allow for setup parameters, airflow, temperature, and diagnostic data to be saved on the phone or be emailed.
- 4) Model GTL116 Transmitter with LonWorks Free Topology Network Interface: Connection capable of providing average airflow and temperature rates across the network.
- 5) Model GTD116 Transmitter with Data-Logger Interface: Capable of logging airflow and temperature rates over specified time intervals.

f. Integral Control Damper and Sleeve:

- 1) Frame and Sleeve: Extruded 6063T5 aluminum with an integral damper frame.
  - a) Thickness: Not less than 0.080-inch (2.0-mm) thickness for each damper section.
  - b) Sleeve Depth: 15 inches (381 mm) for ducted applications and 18 inches (457 mm) for non-ducted applications including damper frame. Non-ducted applications include a 3-inch- (7.6-mm-) radius, aluminum entry flair.
  - c) Installation: Provide an additional 7 inches (178 mm) for non-ducted, 10 inches (254 mm) for ducted, applications between the downstream edge of an intake louver and the leading edge of the entry flair for outside air intake applications that are close coupled to intake louvers.



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- d) Leakage: The damper leakage is not to exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) of face area against 1-inch wg (248.8-Pa) differential static pressure.
- 2) Blades: Extruded 6063T5 aluminum airfoil blades not less than 0.060-inch (1.52-mm) thickness.
  - a) Blade Seals: Extruded EPDM.
  - b) Frame Seals: Extruded silicone secured in an integral slot within the aluminum extrusions.
  - c) Orientation: Parallel or opposed blade configuration as required by application.
- 3) Bearings: Celcon inner bearing fixed to a 7/16-inch (11.1-mm) aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.
- 4) Linkage: Aluminum- and corrosion-resistant zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip, installed inside the frame.
- 5) Control-Damper Actuator: Modulating, electronic, damper actuator of sufficient number and adequate size, factory mounted and tested. Control-damper actuators are specified in Section 230923.12 "Control Dampers."

C. Pitot-Tube Airflow Sensor Station:

- 1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
  - a. [Air Monitor Corp.](#)
  - b. [Azbil North America, Inc.](#)
- 2. Description: Multiple total- and static-pressure sensors positioned at the center of equal area of the station cross section and interconnected by respective averaging manifolds.
  - a. Stations 4 sq. ft. (0.4 sq. m) and Smaller: One total-pressure sensor and one static-pressure sensor for every 16 sq. in. (103 sq. cm) of station area.
  - b. Stations Larger than 4 sq. ft. (0.4 sq. m): One total-pressure sensor and one static-pressure sensor for every 36 sq. in. (232 sq. cm) of station area.
- 3. Casing: Galvanized sheet steel at least 0.079 inch (2.0 mm) thick with coating complying with ASTM A653/A653M, G90 (Z275). Casings are to be stainless steel, 0.0781 inch (2.0 mm) thick, when connected to stainless duct and aluminum, 0.063 inch (1.6 mm) thick, when connected to aluminum duct.



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- a. Joints and Seams: Continuously weld. Clean galvanized areas damaged by welding and coat with aluminum paint.
  - b. Casing Depth: At least 8 inches (200 mm).
  - c. Casing Flanges: Outward flange, minimum flange face 1.5 inches (38 mm).
  - d. Casing Configuration and Size: Match shape (rectangular, round, flat oval) and same size as adjacent duct unless otherwise indicated.
4. Include an open parallel cell air straightener or air equalizer honeycomb mechanically fastened to casing.
- a. Construct straightener or equalizer from Type 3003 aluminum or Type 316 stainless steel, depending on casing material. Use stainless steel for units with stainless steel casings.
5. Construct pressure sensor array from drawn copper or stainless steel tubing. Use stainless steel for units with stainless steel casings. Copper tubing is to comply with ASTM B75 and ASTM B280. Minimum tube wall thickness is to be 0.030 inch (0.8 mm). Include internal piping and external pressure transmitter ports.
6. Station Labeling: Identification label on each station casing indicating model number, size, area, and application-specific airflow range.
7. Performance:
- a. Pressure Loss: 0.015-inch wg (3.8 Pa) at 1000 fpm (5 m/s), or 0.085-inch wg (22.5 Pa) at 2000 fpm (10 m/s).
  - b. Accuracy: Within 2 percent of actual airflow.
  - c. Self-Generated Sound: NC 40 and sound level within the duct is not to be amplified.
  - d. Performance rated and tested in accordance with AMCA 610. Each station shall bear the AMCA seal.

D. Pitot-Tube Fan Inlet Airflow Traverse Sensor:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
  - a. [Air Monitor Corp.](#)
  - b. [Azbil North America, Inc.](#)
2. Traverse manifold designed for mounting in fan inlets.
3. Contain multiple total- and static-pressure sensors placed at concentric area centers along the exterior surface of cylindrical manifold and internally connected to their respective averaging manifolds. Sensors are not to protrude beyond the surface of the manifold nor be adversely affected by particle contamination present in airstream.
4. Manifold (two per inlet) is to have dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal takeoffs and fittings.



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5. Sensors are to be capable of producing steady, non-pulsating signals of standard total- and static-pressure without need for flow corrections or factors, with an accuracy of 3 percent of actual flow over a turndown range of 6 to 1.
6. Manifold Materials: Copper or anodized aluminum.
7. Unless otherwise required by application and without affecting the fan and sensor performance, nominal diameter copper and aluminum manifolds are to be the following:
  - a. For Fan Inlets Smaller Than 20 Inches (500 mm): 0.375 inch (9 mm).
  - b. For Fan Inlets 20 Inches (500 mm) and Larger: 0.75 inch (19 mm).
8. Unless otherwise required by application and without affecting the fan and sensor performance, nominal diameter stainless steel manifolds are to be the following:
  - a. For Fan Inlets Smaller Than 20 Inches (500 mm): 0.375 inch (9 mm).
  - b. For Fan Inlets 20 through 48 Inches (500 through 1200 mm): 0.75 inch (19 mm).
  - c. For Fan Inlets Larger Than 48 Inches (1200 mm): 1.0 inch (25 mm).

E. Piezometer Ring Fan Inlet Airflow Sensor:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
  - a. [Air Monitor Corp.](#)
  - b. [Azbil North America, Inc.](#)
2. In lieu of externally mounted fan inlet airflow sensors, option to provide fans with airflow measurement integral to fan inlet cones for continuous measurement of air volume flow rate.
3. Multiple pressure sensor points strategically placed along the circumference of the inlet cone and internally connected to an averaging ring manifold located behind the inlet cone.
4. Sensor points are not to protrude beyond the surface of the inlet cone nor be adversely affected by particle contamination present in the airstream.
5. Sensor is to produce steady, non-pulsating signals to achieve accuracy within 5 percent of actual airflow.
6. Sensor is to be non-intrusive and not impact fan performance.
7. Product is to be a standard offering of the fan manufacturer and include published literature with supporting test data to validate sensor performance.

## 2.4 AIRFLOW SWITCHES

A. Polymer Film Sail Switch:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers



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offering products that may be incorporated into the Work include, but not limited to, the following]:

- a. [Air Monitor Corp.](#)
- b. [Azbil North America, Inc.](#)

2. Performance:

- a. Suitable for applications operating at velocities up to 400 fpm (2.0 m/s).
- b. Suitable for mounting with air direction in horizontal, vertical up or down.
- c. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- d. Voltage: 24-, 120-, 240-V ac.
- e. Normally Open Full Load Current: 2 A at 120-V ac.
- f. Normally Closed Full Load Current: 1 A at 120-V ac.
- g. Normally open switch actuates at 250 fpm (1.3 m/s) and opens at 75 fpm (0.4 m/s).
- h. Normally closed switch actuates at 75 fpm (0.4 m/s) and closes at 250 fpm (1.3 m/s).
- i. Maximum Process Temperature: 170 deg F (77 deg C).
- j. Maximum Ambient Temperature: 125 deg F (52 deg C).

3. Construction:

- a. Polyester film sail encasing a wire frame.
- b. Sail actuates a SPDT snap switch.
- c. Enclosure Material: Zinc-plated steel.
- d. Enclosure with removable cover.
- e. NEMA 250, Type 1 enclosure.
- f. Removable spring counterbalances sail to allow mounting in either vertical (up or down) or horizontal airflow.
- g. Electrical Connections: Screw terminals.
- h. Conduit Connections: 1/2-inch (16-mm) trade size conduit knock outs on top and bottom.

B. Stainless Steel Single Vane Switch:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:

- a. [Air Monitor Corp.](#)
- b. [Azbil North America, Inc.](#)

2. Description:

- a. Velocities up to 2000 fpm (10.2 m/s).
- b. Suitable for mounting with air direction in horizontal.

3. Performance:



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- a. Voltage: 125-, 240-, and 480-V ac.
  - b. Full Load Current: 9.8 A at 125-V ac.
  - c. Field-Adjustable Velocity Set Point: 400 to 1600 fpm (2.0 to 8.2 m/s).
  - d. Maximum Process Temperature: 180 deg F (82 deg C).
  - e. Maximum Ambient Temperature: 125 deg F (52 deg C).
4. Construction:
- a. Stainless steel vane.
  - b. Vane actuates a SPDT snap switch.
  - c. Enclosure Material: Die-cast metal.
  - d. Enclosure with removable cover.
  - e. NEMA 250, Type 1 enclosure.
  - f. Screw set-point adjustment.
  - g. Electrical Connections: Screw terminals.
  - h. Conduit Connections: 1-inch (27-mm) trade size conduit knock outs on top and bottom.

## 2.5 AIRFLOW TRANSMITTERS

### A. Airflow Transmitter with 0.10 Percent Accuracy and Auto-Zero Feature:

- 1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
  - a. [Air Monitor Corp.](#)
  - b. [Azbil North America, Inc.](#)
- 2. Transmitter is to receive total- and static-pressure signals from a primary element, amplify signals, extract the square root, and scale the signals to produce 4- to 20-mA dc output signals linear to airflow.
- 3. NEMA 250, Type 1 enclosure.
- 4. Construct assembly so that shock, vibration, and pressures surges of up to 1 psig (6.9 kPa) will neither harm transmitter, nor affect its accuracy.
- 5. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals. The automatic zeroing circuit is to re-zero transmitter to within 0.1 percent of true zero.
- 6. Performance:
  - a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
  - b. Calibrated Span: Field adjustable, minus 40 percent of the range.
  - c. Accuracy: Within 0.10 percent of natural span.
  - d. Repeatability: Within 0.15 percent of calibrated span.
  - e. Linearity: Within 0.2 percent of calibrated span.
  - f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.



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7. Integral digital LED or digital display for continuous indication of airflow.

B. Airflow Transmitters with 0.25 Percent Accuracy and Auto-Zero Feature:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
  - a. [Air Monitor Corp.](#)
  - b. [Azbil North America, Inc.](#)
2. Transmitter is to receive total- and static-pressure signals from a flow element, amplify signals, extract the square foot, and scale the signals to produce 4- to 20-mA dc output signals linear to airflow.
3. NEMA 250, Type 1 enclosure.
4. Construct assembly so shock, vibration, and pressures surges of up to 1 psig (6.9 kPa) will neither harm transmitter, nor affect its accuracy.
5. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals. The automatic zeroing circuit is to re-zero the transmitter to within 0.1 percent of true zero.
6. Performance:
  - a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
  - b. Calibrated Span: Field adjustable, minus 40 percent of the range.
  - c. Accuracy: Within 0.25 percent of natural span.
  - d. Repeatability: Within 0.15 percent of calibrated span.
  - e. Linearity: Within 0.2 percent of calibrated span.
  - f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.
7. Integral digital display for continuous indication of airflow.

C. Pressure Differential Transmitters for Airflow Measurement:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
  - a. [Air Monitor Corp.](#)
  - b. [Azbil North America, Inc.](#)
2. Performance:
  - a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
  - b. Accuracy: Within 0.25 percent of the full-scale range.
  - c. Hysteresis: Within 0.10 percent of full scale.
  - d. Repeatability: Within 0.05 percent of full scale.



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- e. Stability: Within one percent of span per year.
  - f. Overpressure: 10 psig (69 kPa).
  - g. Temperature Limits: Zero to 150 deg F (Minus 18 to plus 66 deg C).
  - h. Compensate Temperature Limits: 40 to 150 deg F (4 to 66 deg C).
  - i. Thermal Effects: 0.033 percent of full scale per degree F.
  - j. Shock and vibration are not to harm the transmitter.
3. Output Signals:
- a. Analog Current Signal:
    - 1) Two-wire, 4- to 20-mA dc current source.
    - 2) Signal capable of operating into 800-ohm load.
  - b. Analog Voltage Signal:
    - 1) Three wire, zero to 10 V.
    - 2) Minimum Load Resistance: 1000 ohms.
4. Display: Four-digit digital with minimum 0.4-inch- (10-mm-) high numeric characters.
5. Operator Interface:
- a. Zero and span adjustments located behind cover.
6. Construction:
- a. Plastic casing with removable plastic cover.
  - b. Fittings: Swivel fittings for connection to copper tubing or barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.
  - c. Screw terminal block for wire connections.
  - d. Vertical plane mounting.
  - e. NEMA 250, Type 4.
  - f. Mounting Bracket: Appropriate for installation.
- D. Pressure Differential Indicating Transmitter, Switch, and Controller for Airflow Measurement:
- 1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
    - a. [Air Monitor Corp.](#)
    - b. [Azbil North America, Inc.](#)
  - 2. Description:
    - a. Three-in-one instrument, including digital display, control relay switches, and a transmitter with a current output.



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- b. Field configurable for pressure, velocity, and volumetric flow applications through user interface.
  - c. Select instrument range based on application.
3. Performance:
- a. Accuracy including hysteresis and repeatability:
    - 1) Ranges Less than 5-Inch wg (1250 Pa): Within 1 percent.
    - 2) Other Ranges: Within 0.5 percent at 77 deg F (25 deg C).
  - b. Stability: Within 1 percent per year.
  - c. Response Time: 250 ms.
  - d. Overpressure:
    - 1) Ranges Less than 50-Inch wg (12.5 kPa): 5 psi (34.5 kPa).
    - 2) Range of 100-Inch wg (25 kPa): 9 psi (62 kPa).
  - e. Temperature Limits: 32 to 140 deg F (Zero to 60 deg C).
  - f. Thermal Effects: 0.020 percent per deg F (deg C).
  - g. Warm-up Period: One hour.
4. Controller: Programming through menu keys to access five menus.
- a. Security level.
  - b. Pressure, velocity, or flow application.
  - c. Engineering units.
  - d. K-factor for use with flow application.
  - e. Set-point control only; set-point and alarm operation; alarm operation as high, low, or high/low with manual; or automatic reset and delay.
  - f. View high and low readings.
  - g. Digital dampening for smoothing erratic applications.
  - h. Scaling of analog output to fit range and field calibration.
5. Display:
- a. Four-digit digital, with minimum 0.4-inch- (10-mm-) high alphanumeric characters.
  - b. Four LED indicators; two LEDs for set point and two LEDs for alarm status.
6. Operator Interface:
- a. Set-point adjustment through keypad on face of instrument.
  - b. Zero and span adjustments accessible through menu.
  - c. Programming through keypad.
7. Output Analog Signal: Two-wire, 4- to 20-mA dc current source; capable of operating into a 900-ohm load.



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- 8. Output Digital Signal: Two, SPDT relays; each rated for 1 A at 30-V ac or 30-V dc.
- 9. Construction:
  - a. Die-cast aluminum casing and bezel.
  - b. Connections on side and back.
  - c. Vertical plane mounting.
  - d. NEMA 250, Type 1 rating.
  - e. Nominal 4-inch- (100-mm-) diameter face.
  - f. Mounting Bracket: Appropriate for installation.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Provide the services of an independent inspection agency to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
  - 1. Indicate dimensioned locations with mounting height for all surface-mounted products to walls and ceilings on shop drawings.
  - 2. Do not begin installation without submittal approval of mounting location.
- E. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.
- F. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTRUMENT APPLICATIONS

- A. Select from instrument types to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.



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B. Thermal Airflow Measurement Stations:

1. For Air-Ducted/Plenum:
  - a. Measured Velocities Greater Than 200 fpm (1.0 m/s): Thermal airflow measurement station.
  - b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.
2. For Packaged HVAC Units, 12.5 Tons (44.0 kW) or Smaller:
  - a. Measured Velocities Greater Than 200 fpm (1.0 m/s): Thermal airflow measurement station.
  - b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.
3. For Directional Airflow Sensors:
  - a. Measured Velocities Greater Than 50 fpm (0.25 m/s): Thermal airflow measurement station.
  - b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.
4. For Damper-Mounted Airflow Stations:
  - a. Measured Velocities Greater Than 200 fpm (1.0 m/s): Thermal airflow measurement station.
  - b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.

C. Duct-Mounted Airflow Sensors:

1. Measured Velocities 500 fpm (2.5 m/s) and Less: Thermal airflow station.
2. Measured Velocities Greater than 500 fpm (2.5 m/s): Pitot-tube airflow sensor station.

D. Damper-Mounted Airflow Sensors:

1. Measured Velocities 400 fpm (2.0 m/s) and Less: Thermal airflow station.
2. Measured Velocities Greater than 500 fpm (2.5 m/s): Pitot-tube airflow sensor station.

E. Fan-Mounted Airflow Sensors:

1. Measured Velocities 500 fpm (2.5 m/s) and Less: Thermal airflow station.
2. Measured Velocities Greater than 500 fpm (2.5 m/s): Piezometer ring fan inlet airflow sensor.

F. Airflow Switches:



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1. Measured Velocities 400 fpm (2.0 m/s) and Less: Polymer film sail switch.
2. Measured Velocities Greater than 400 fpm (2.0 m/s): Stainless steel single-vane switch.

G. Airflow Transmitters for Use with Pitot-Tube-Type Sensors:

1. Exhaust Air Airflow: Airflow transmitter with 0.25 percent accuracy and auto-zero feature.
2. Outdoor Air Airflow: Airflow transmitter with 0.25 percent accuracy and auto-zero feature.
3. Return Air Airflow: Airflow transmitter with 0.25 percent accuracy and auto-zero feature.
4. Supply Air Airflow: Airflow transmitter with 0.25 percent accuracy and auto-zero feature.

### 3.3 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- D. Install ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- E. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

### 3.4 ELECTRICAL CONNECTIONS

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."



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- D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

### 3.5 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:

1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
3. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Mounting Height:

1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height is to comply with codes and accessibility requirements.
2. Mount switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of 42 to 72 inches (1050 to 1800 mm) above the adjacent floor, grade, or service catwalk or platform.
  - a. Make every effort to mount at 60 inches (1500 mm).

- C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

### 3.6 INSTALLATION OF FLOW INSTRUMENTS

A. Airflow Sensors:

1. Install sensors in straight sections of duct with manufacturer-recommended straight duct upstream and downstream of sensor.
2. Installed sensors are to be accessible for visual inspection and service. Install access door(s) in duct or equipment located upstream of sensor, to allow service personnel to hand clean sensors.



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B. Transmitters:

1. Install airflow transmitters serving an air system in a single location adjacent to or within system control panel.
2. Install liquid flow transmitters, not integral to sensors, in vicinity of sensor. Where multiple flow transmitters serving same system are located in same room, co-locate transmitters by system to provide service personnel a single and convenient location for inspection and service.

3.7 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing are to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification and on face of ceiling directly below instruments concealed above ceilings.

3.8 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
- B. Wash and shine glazing.
- C. Polish glossy surfaces to a clean shine.

3.9 CHECKOUT PROCEDURES

- A. Description:
  1. Check out installed products before continuity tests, leak tests, and calibration.
  2. Check instruments for proper location and accessibility.
  3. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
  4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
- B. Flow Instrument Checkout:
  1. Verify that sensors are installed correctly with respect to flow direction.
  2. Verify that sensor attachment is properly secured and sealed.
  3. Verify that processing tubing attachment is secure and isolation valves have been provided.



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4. Inspect instrument tag against approved submittal.
5. Verify that recommended upstream and downstream distances have been maintained.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration are to meet instrument manufacturer's recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments are to have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent is to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after-calibration-indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.



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F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.11 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service is to include six months' full maintenance by skilled employees of systems and equipment Installer. Include annual preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner is to have right to make additional copies of video for internal use without paying royalties.

**END OF SECTION 230923.14**



## **SECTION 230923.22 - POSITION INSTRUMENTS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes: Position limit switches for use in direct-digital control (DDC) systems for HVAC.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data: For position limit switches.
  - 1. Include operating characteristics, electrical characteristics, and furnished accessories indicating default control signal with loss of power and electrical power requirements.
  - 2. Include product description with complete technical data and product specification sheets.
- B. Shop Drawings:
  - 1. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Include diagrams for power, signal, and control wiring.
  - 3. Include number-coded identification system for unique identification of wiring.

### **PART 2 - PRODUCTS**

#### **2.1 POSITION LIMIT SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. OMRON Corporation.
- C. Description: Select type of actuating head (plunger, roller lever, or rod) to suit application.



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1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Performance:

1. Life Expectancy: Not less than 30 million mechanical operations and 750,000 electrical operations.
2. Operating Frequency: 300 mechanical operations per minute and 30 electrical operations per minute.
3. Voltage: 125-, 250-, 480-, and 600-V ac or 8-, 12-, 14-, 24-, 30-, 48-, 125-, and 250-V dc, as required by application.
4. Current Rating: As required by application.
5. Temperature Rise: 50 deg C.
6. Ambient Temperature: 14 to 175 deg F (Minus 10 to 79 deg C).
7. Ambient Relative Humidity: 35 to 95 percent.

E. Construction:

1. NEMA 250, Type 4X enclosure.
2. Switch Type: SPDT or DPDT, as required by application.
3. Status indicator integral to switch. Field switchable to light when contacts are actuated and operating, or contacts are free and not operating.
4. Electrical Connection: Screw or plug-in terminals.
5. Conduit Connection: NPS 1/2 (DN 50).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.



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- B. Properly support instruments, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to a force.
- C. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not to overstress threads by using excessive force or oversized wrenches.
  - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- D. Install products in locations that are accessible and that permit maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

### 3.3 ELECTRICAL CONNECTIONS

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

### 3.4 INSTALLATION OF POSITION INSTRUMENTS

- A. Mounting Location:
  - 1. Rough-in instrument-mounting locations before setting instruments and routing, cable, wiring, and conduit to final location.
  - 2. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
- B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated, using neoprene gaskets or grommets.



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3.5 ADJUSTMENT, CALIBRATION, AND TESTING

A. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

B. Switches: Calibrate switches to make or break contact at set points indicated.

**END OF SECTION 230923.22**



## **SECTION 23 09 23.23 - PRESSURE INSTRUMENTS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Air-pressure sensors.
2. Air-pressure switches.
3. Air-pressure transmitters.

#### **1.2 DEFINITIONS**

- A. HART:** Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a control, asset management, safety, or other system using any control platform.

#### **1.3 ACTION SUBMITTALS**

**A. Product Data:**

1. Air-pressure sensors.
2. Air-pressure switches.
3. Air-pressure transmitters.

**B. Product Data Submittals:** For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.

**C. Shop Drawings:**



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1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Product installation location shown in relationship to room, duct, pipe, and equipment.
  2. Wall-mounted instruments located in finished space, showing relationship to light switches, fire alarm devices, and other installed devices.
  3. Size and location of wall access panels for instruments installed behind walls.
  4. Size and location of ceiling access panels for instruments installed in accessible ceilings.
- B. Product Certificates: For each product requiring a certificate.
- C. Product Test Reports: For each product requiring test performed by manufacturer and witnessed by a qualified testing agency.
- D. Source quality-control reports.
- E. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Environmental Conditions:
  1. Instruments must operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.



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- a. If instrument alone cannot comply with requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure to be internally insulated, electrically heated and cooled, filtered, and ventilated as required by instrument and application.
- 2. Instruments and accessories are to be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated are to be housed in protective secondary enclosures. Instrument-installed location to dictate following NEMA 250 enclosure requirements:
  - a. Outdoors, Protected: Type 2.
  - b. Outdoors, Unprotected: Type 4.
  - c. Indoors, Heated with Filtered Ventilation: Type 1.
  - d. Indoors, Heated with Nonfiltered Ventilation: Type 2.
  - e. Indoors, Heated and Air-Conditioned: Type 1.
  - f. Mechanical Equipment Rooms:
    - 1) Air-Moving Equipment Rooms: Type 2.
  - g. Localized Areas Exposed to Washdown: Type 4.
  - h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2.
  - i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
  - j. Hazardous Locations: Explosion-proof rating for condition.
  - k. .

## 2.2 AIR-PRESSURE SENSORS

### A. Duct Insertion Static Pressure Sensor:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Azbil North America, Inc.](#)
- 2. Insertion length to be at 4 inches (100 mm).
- 3. Sensor with four radial holes of 0.04-inch (1-mm) diameter.
- 4. Brass or stainless steel construction.
- 5. Sensor with threaded end support, sealing washers and nuts.
- 6. Connection: NPS 1/4 (DN 6) compression fitting.
- 7. Suitable for flat oval, rectangular, and round duct configurations.

### B. Duct Insertion Static Pressure Sensor - Dual Orifice Design:



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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Azbil North America, Inc.](#)
2. Sensor probe with two opposing orifices designed to reduce error-associated air velocity.
3. Sensor insertion length to be 4 inches (100 mm).
4. Construct sensor of 6061-T6 aluminum alloy or Type 304 stainless steel.
5. Connection: Threaded, NPS 1/8 (DN 6) swivel fitting for connection to copper tubing or NPS 1/4 (DN 10) barbed fitting for connection to polyethylene tubing.
6. Sensor probe attached to a mounting flange with neoprene gasket and two holes for fasteners.
7. Mounting flange to be suitable for flat oval, rectangular, and round duct configurations.
8. Pressure Rating: 10 psig (69 kPa).

C. Duct Traverse Static Pressure Sensor:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Azbil North America, Inc.](#)
2. Sensor to traverse the duct cross section and have at least one pickup point every 6 inches (150 mm) along length of sensor.
3. Construct sensor of 18-gauge Type T6063-T5 extruded and anodized aluminum.
4. Sensor supported with threaded rod, sealing washer, and nut at one end and a mounting plate with gasket at other end.
5. Mounting plate with threaded, NPS 3/8 (DN 12) compression fitting for connection to tubing.
6. Accuracy within 1 percent of actual operating static pressure.
7. Dual offset static sensor design to provide accurate sensing of duct static pressure in the presence of turbulent and rotational airflows with a maximum 30-degree yaw and pitch.
8. Suitable for velocities of 100 to 10000 fpm (0.51 to 51 m/s) and temperatures of up to 200 deg F (93 deg C).
9. Sensor air resistance to be less than 0.1 times the velocity pressure at probe-operating velocity.
10. Suitable for flat oval, rectangular, and round duct configurations.

D. Outdoor Static Pressure Sensor:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Azbil North America, Inc.](#)
2. Provides average outdoor pressure signal.



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3. Sensor with no moving parts.
  4. Kit includes sensor, vinyl tubing mounting hardware.
- E. Space Static Pressure Sensor for Wall Mounting - Stainless Steel Wall Plate:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [Azbil North America, Inc.](#)
  2. 100-micron filter mounted in stainless steel wall plate senses static pressure.
  3. Wall plate provided with gasket and screws, and sized to fit standard single-gang electrical box.
  4. Back of sensor plate fitted with brass barbed fitting for tubing connection.
- F. Space Static Pressure Sensor for Recessed Ceiling Mounting:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [Azbil North America, Inc.](#)
  2. Stainless steel round plate with perforated center arranged to sense space static pressure. Exposed surfaces provided with brush finish.
  3. Sensor intended for flush mount on face of ceiling with pressure chamber recessed in ceiling plenum.
  4. Back of sensor plate fitted with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 0.125-inch (3-mm) fitting for concealed tubing connection.
  5. Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm (5.1 m/s) from a 360-degree radial source.
- G. Space Static Pressure Sensor for Exposed or Suspended Mounting:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [Azbil North America, Inc.](#)
  2. Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm (5.1 m/s) from a 360-degree radial source.
  3. Stainless steel with perforations arranged to sense space static pressure. Exposed surfaces provided with brush finish.
  4. Sensor fitted with multiple sensing ports, pressure impulse suppression chamber, and airflow shielding.
  5. Surface-mounted sensor provided with solid mounting plate intended for mount to ceiling with pressure chamber exposed to view.



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6. Surface-mounted sensor with 0.125-inch (3-mm) fitting for exposed tubing connection.
7. Suspended sensor intended for pendent mount with pressure chamber exposed to view.
8. Suspended sensor with NPS 1/2 (DN 15) fitting for exposed pipe or tubing connection.

## 2.3 AIR-PRESSURE SWITCHES

### A. Air-Pressure Differential Switch:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Azbil North America, Inc.](#)
2. Diaphragm operated to actuate an SPDT snap switch.
  - a. Fan safety shutdown applications: Switch with manual reset.
3. Electrical Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
4. Enclosure Conduit Connection: Knock out or threaded connection.
5. User Interface: Screw-type set-point adjustment located inside removable enclosure cover.
6. High and Low Process Connections: Threaded, NPS 1/8 (DN 6).
7. Enclosure:
  - a. Dry Indoor Installations: NEMA 250, Type 1.
  - b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
  - c. Hazardous Environments: Explosion proof.
8. Operating Data:
  - a. Electrical Rating: 15 A at 120- to 480-V ac.
  - b. Pressure Limits:
    - 1) Continuous: 45 inches wg (11.2 kPa).
    - 2) Surge: 10 psig (68.9 kPa).
  - c. Temperature Limits: Minus 30 to 180 deg F (Minus 34 to 82 deg C).
  - d. Operating Range: Approximately 2 times set point.
  - e. Repeatability: Within 3 percent.
  - f. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### B. Air-Pressure Differential Switch with Set-Point Indicator:



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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Azbil North America, Inc.](#)
2. Diaphragm operated to actuate an SPDT snap switch.
3. Electrical Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
4. Enclosure Conduit Connection: Knock out or threaded connection.
5. User Interface: Screw-type set-point adjustment with enclosed set-point indicator and scale.
6. High and Low Process Connections: Threaded, NPS 1/8 (DN 6).
7. Enclosure:
  - a. Dry Indoor Installations: NEMA 250, Type 1.
  - b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
  - c. Hazardous Environments: Explosion proof.
8. Operating Data:
  - a. Electrical Rating: 15 A at 120- to 480-V ac.
  - b. Pressure Limits:
    - 1) Continuous: 10 psig (69 kPa).
    - 2) Surge: 25 psig (172 kPa).
  - c. Temperature Limits: Minus 30 to 110 deg F (Minus 34 to 43 deg C).
  - d. Operating Range: Approximately 2 times set point.
  - e. Repeatability: Within 1 percent.
  - f. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.4 AIR-PRESSURE TRANSMITTERS

### A. Air-Pressure Differential Transmitter with Display:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Azbil North America, Inc.](#)
2. Performance:
  - a. Range: Approximately 2 times set point.
  - b. Accuracy: Within 0.25 percent of the full-scale range.
  - c. Hysteresis: Within 0.10 percent of full scale.
  - d. Repeatability: Within 0.05 percent of full scale.



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- e. Stability: Within 1 percent of span per year.
  - f. Overpressure: 10 psig (69 kPa).
  - g. Temperature Limits: Zero to 150 deg F (Minus 18 to 66 deg C).
  - h. Compensate Temperature Limits: 40 to 150 deg F (4 to 66 deg C).
  - i. Thermal Effects: 0.033 percent of full scale per degree F.
  - j. Shock and vibration to not harm the transmitter.
3. Output Signals:
- a. Analog Current Signal:
    - 1) Two-wire, 4- to 20-mA dc current source.
    - 2) Signal capable of operating into 800-ohm load.
  - b. Analog Voltage Signal:
    - 1) Three wire, zero to 10 V.
    - 2) Minimum Load Resistance: 1000 ohms.
4. Display: Four-digit digital display with minimum 0.4-inch- (10-mm-) high numeric characters.
5. Operator Interface: Zero and span adjustments located behind cover.
6. Construction:
- a. Plastic casing with removable plastic cover.
  - b. Threaded, NPS 1/4 (DN 10) swivel fittings for connection to copper tubing or NPS 3/16 (DN 7) barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.
  - c. Screw terminal block for wire connections.
  - d. Vertical plane mounting.
  - e. NEMA 250, Type 4.
  - f. Provide mounting bracket suitable for installation.
- B. Air-Pressure Differential Transmitter:
- 1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
    - a. [Azbil North America, Inc.](#)
  - 2. Performance:
    - a. Range: Approximately 2 times set point.
    - b. Accuracy: Within 0.25 percent of the span at reference temperature of 70 deg F (21 deg C).
    - c. Hysteresis: Within 0.02 percent of the span.
    - d. Repeatability: Within 0.05 percent of the calibrated span.
    - e. Stability: Within 0.25 percent of span per year.



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- f. Overpressure: 15 psig (103 kPa).
  - g. Temperature Limits: Minus 20 to 160 deg F (Minus 29 to 71 deg C).
  - h. Compensate Temperature Limits: 35 to 135 deg F (2 to 57 deg C).
  - i. Thermal Effects: 0.015 percent of full scale per degree F.
  - j. Warm-up Time: Within 5 seconds.
  - k. Response Time: 250 ms.
  - l. Shock and vibration to not harm the transmitter.
3. Output Signals:
- a. Analog Current Signal:
    - 1) Two-wire, 4- to 20-mA dc current source.
    - 2) Signal capable of operating into 1000-ohm load.
  - b. Analog Voltage Signal:
    - 1) Three wire, zero to 5 V.
    - 2) Minimum Load Resistance: 1000 ohms.
4. Operator Interface:
- a. Zero and span adjustments within 10 percent of full span.
  - b. Potentiometer adjustments located on face of transmitter.
5. Construction:
- a. Type 300 stainless steel enclosure.
  - b. Swivel fittings for connection to copper tubing or barbed fittings for connection to polyethylene tubing. Fittings on front of instrument enclosure.
  - c. Screw terminal block for wire connections.
  - d. Vertical plane mounting.
  - e. NEMA 250, Type 2.
  - f. Mounting Bracket: Appropriate for installation.
  - g. Reverse wiring protected.
  - h. Calibrate to NIST-traceable standards and provide each transmitter with a certificate of calibration.
- C. Air-Pressure Differential Transmitter with 0.25 Percent Accuracy and Auto Zero Feature:
- 1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
    - a. [Azbil North America, Inc.](#)
  - 2. Description:



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- a. 4- to 20-mA dc output signal.
- b. NEMA 250, Type 1 enclosure.
- c. Construct assembly so shock, vibration, and pressure surges of up to 1 psig (6.9 kPa) will neither harm nor affect the accuracy of the transmitter.
- d. Transmitter with automatic zeroing circuit capable of automatically readjusting the transmitter to zero at predetermined time intervals. The automatic zeroing circuit to re-zero transmitter to within 0.1 percent of true zero.
- e. Performance:
  - 1) Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
  - 2) Calibrated Span: Field adjustable, minus 40 percent of the range.
  - 3) Accuracy: Within 0.25 percent of natural span.
  - 4) Repeatability: Within 0.15 percent of calibrated span.
  - 5) Linearity: Within 0.2 percent of calibrated span.
  - 6) Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.
- f. Integral digital display for continuous indication of pressure differential.

D. Air-Pressure Differential Indicating Transmitter, Switch, and Controller:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [Azbil North America, Inc.](#)
- 2. Description:
  - a. Three-in-one instrument, including digital display, control relay switches, and a transmitter with a current output.
  - b. Field configurable for pressure, velocity, and volumetric flow applications through user interface.
  - c. Select instrument range based on application. Range to be approximately 2 times set point.
- 3. Performance:
  - a. Accuracy Including Hysteresis and Repeatability:
    - 1) Within 1 percent for ranges less than 5 in. wg (1250 Pa).
    - 2) Within 0.5 percent at 77 deg F (25 deg C) for other ranges.
  - b. Stability: Within 1 percent per year.
  - c. Response Time: 250 ms.
  - d. Overpressure: 5 psig (34 kPa) for instrument ranges less than 50 in wg (12.5 kPa) and 9 psig (62 kPa) for 100 in. wg (25 kPa) range.
  - e. Temperature Limits: 32 to 140 deg F (Zero to 60 deg C).



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- f. Thermal Effects: 0.020 percent per degree F.
  - g. Warm-up Period: One hour.
- 4. Controller Programming through Menu Keys to Access Five Menus:
  - a. Security level.
  - b. Pressure, velocity, or flow application.
  - c. Engineering units.
  - d. K-factor for use with flow application.
  - e. Set-point control only; set-point and alarm operation; and alarm operation as high, low, or high/low with manual or automatic reset and delay.
  - f. View high and low readings.
  - g. Digital dampening for smoothing erratic applications.
  - h. Scaling of analog output to fit range and field calibration.
- 5. Display:
  - a. Digital, four-digit display with backlight, with 0.4-inch- (10-mm-) high alphanumeric characters.
  - b. Four indicators; two for set point and two for alarm status.
- 6. Operator Interface:
  - a. Set-point adjustment through keypad on face of instrument.
  - b. Zero and span adjustments accessible through menu.
  - c. Programming through keypad.
- 7. Analog Output Signal:
  - a. Two-wire, 4- to 20-mA dc current source.
  - b. Signal capable of operating into a 900-ohm load.
- 8. Digital Output Signal:
  - a. Two SPDT relays.
  - b. Each rated for one amp at 30-V ac or dc.
- 9. Construction:
  - a. Die cast-aluminum casing and bezel.
  - b. Threaded, NPS 1/8 (DN 6) connections on side and back.
  - c. Vertical plane mounting.
  - d. NEMA 250, Type 1.
  - e. Nominal 4-inch- (100-mm-) diameter face.
  - f. Mounting Bracket: Appropriate for installation.



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2.5 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled pressure instruments, as indicated by instrument requirements. Affix standards organization's certification and label.
- B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PRESSURE INSTRUMENT APPLICATIONS

- A. Duct-Mounted Static Pressure Sensors:
  - 1. Insert system : Duct insertion static pressure sensor.
- B. Space Static Pressure Sensors:
  - 1. Space static pressure sensor for wall mounting.
- C. Air-Pressure Differential Switches:
  - 1. Air-pressure differential switch with set-point indicator.
- D. Air-Pressure Differential Transmitters:
  - 1. Duct, >: Air-pressure differential transmitter with 0.25 percent accuracy and auto zero feature.
  - 2. Space, Air-pressure differential transmitter with 0.25 percent accuracy and auto zero feature.



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3.3 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to a force.
- C. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- D. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not to overstress threads by using excessive force or oversized wrenches.
  - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 ELECTRICAL CONNECTIONS

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 26 28 16 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 26 05 33.13 "Conduits for Electrical Systems."

3.5 INSTALLATION OF PRESSURE INSTRUMENTS

- A. Mounting Location:
  - 1. Rough-in: Outline instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.



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2. Install switches and transmitters for air and liquid pressure associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
  3. Install liquid and steam pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
  4. Install air-pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
  5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
  6. Install instruments (except pressure gauges) in steam, liquid, and liquid-sealed piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
  7. Install instruments in dry gas and noncondensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.
- B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.
- C. Duct Pressure Sensors:
1. Install sensors using manufacturer's recommended upstream and downstream distances.
  2. Unless indicated on Drawings, locate sensors approximately 67 percent of distance of longest hydraulic run. Location of sensors to be submitted and approved before installation.
  3. Install mounting hardware and gaskets to make sensor installation airtight.
  4. Route tubing from the sensor to transmitter.
  5. Use compression fittings at terminations.
  6. Install sensor in accordance with manufacturer's instructions.
  7. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.
- D. Outdoor Pressure Sensors:
1. Install roof-mounted sensor in least-noticeable location and as far away from exterior walls as possible.
  2. Locate wall-mounted sensor in an inconspicuous location.
  3. Submit sensor location for approval before installation.
  4. Verify signal from sensor is stable and consistent to all connected transmitters. Modify installation to achieve proper signal.



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5. Route outdoor signal pipe full size of sensor connection to transmitters. Install branch connection of size required to match to transmitter.
6. Install sensor signal pipe with dirt leg and drain valve below roof penetration.
7. Insulate signal pipe with flexible elastomeric insulation as required to prevent condensation.
8. Connect roof-mounted signal pipe exposed to outdoors to building grounding system.

E. Air-Pressure Differential Switches:

1. Install air-pressure sensor in system for each switch connection. Install sensor in an accessible location for inspection and replacement.
2. A single sensor may be used to share a common signal to multiple pressure instruments.
3. Install access door in duct and equipment to access sensors that cannot be inspected and replaced from outside.
4. Route NPS 3/8 (DN 12) tubing from sensor to switch connection.
5. Do not mount switches on rotating equipment.
6. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
7. Install switches in an easily accessible location serviceable from floor.
8. Install switches adjacent to system control panel if within 50 feet (15 m); otherwise, locate switch in vicinity of system connection.

### 3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification and on face of ceiling directly below instruments concealed above ceilings.

### 3.7 CHECKOUT PROCEDURES

- A. Check out installed products before continuity tests, leak tests, and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.



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3.8 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
4. Equipment and procedures used for calibration to comply with instrument manufacturer's recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments to have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of project design values.



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3.9 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by manufacturer's authorized service representative. Include annual preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper operation. Parts and supplies to be manufacturer's authorized replacement parts and supplies.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate pressure instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner has right to make additional copies of video for internal use without paying royalties.

**END OF SECTION 23 09 23.23**



## SECTION 23 09 23.27 - TEMPERATURE INSTRUMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Air temperature sensors.
2. Combination air temperature sensors and switches.
3. Air temperature switches.
4. Air temperature RTD transmitters.

#### 1.2 DEFINITIONS

- A. HART (Highway Addressable Remote Transducer) Protocol: The global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bidirectional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from a technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.
- B. RTD: Resistance temperature detector.

#### 1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Air temperature sensors.
2. Combination air temperature sensors and switches.
3. Air temperature switches.
4. Air temperature RTD transmitters.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.



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- 4. Installation operation and maintenance instructions, including factors affecting performance.
- C. Shop Drawings:
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
  - 4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.
- D. Samples: For each exposed product installed in finished space.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Product installation location shown in relationship to room, duct, pipe, and equipment.
  - 2. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
  - 3. Sizes and locations of wall access panels for instruments installed behind walls.
  - 4. Sizes and locations of ceiling access panels for instruments installed in inaccessible ceilings.
- B. Product Certificates: For each product requiring a certificate.
- C. Product Test Reports: For air temperature sensors combination air temperature sensors and switches air temperature switches air temperature RTD transmitters, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Field quality-control reports.

#### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.



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## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

#### A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
  - a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated and cooled, filtered, and ventilated as required by instrument and application.
2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument's installed location shall dictate following NEMA 250 enclosure requirements:
  - a. Outdoors, Protected: Type 2.
  - b. Outdoors, Unprotected: Type 4.
  - c. Indoors, Heated with Filtered Ventilation: Type 1.
  - d. Indoors, Heated with Non-Filtered Ventilation: Type 2.
  - e. Indoors, Heated and Air Conditioned: Type 1.
  - f. Mechanical Equipment Rooms:
    - 1) Air-Moving Equipment Rooms: Type 2.
  - g. Localized Areas Exposed to Washdown: Type 4.
  - h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2.
  - i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
  - j. Hazardous Locations: Explosion-proof rating for condition.
  - k. .

### 2.2 AIR TEMPERATURE SENSORS

#### A. Platinum RTDs: Common requirements:

1. 100 or 1000 ohms at 0 deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
3. Performance Characteristics:



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- a. Range: Minus 50 to 275 deg F (Minus 46 to 135 deg C).
    - b. Interchangeable Accuracy: At 32 deg F (0 deg C) within 0.5 deg F (0.3 deg C).
    - c. Repeatability: Within 0.5 deg F (0.3 deg C).
    - d. Self-Heating: Negligible.
  4. Transmitter Requirements:
    - a. Transmitter required for each 100-ohm RTD.
    - b. Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.
- B. Platinum RTD, Single-Point Air Temperature Duct Sensors:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [ETI.](#)
    - b. [WindowMaster Clearline Inc.](#)
  2. 100or 1000 ohms.
  3. Temperature Range: Minus 50 to 275 deg F (Minus 45 to 135 deg C).
  4. Probe: Single-point sensor with a stainless steel sheath.
  5. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches (450 mm) long.
  6. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
  7. Gasket for attachment to duct or equipment to seal penetration airtight.
  8. Conduit Connection: 1/2-inch (16-mm) trade size.
- C. Platinum RTD, Air Temperature Averaging Sensors:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [ETI.](#)
    - b. [WindowMaster Clearline Inc.](#)
  2. 100 or 1000 ohms.
  3. Temperature Range: Minus 50 to 275 deg F (Minus 45 to 135 deg C).
  4. Multiple sensors to provide average temperature across entire length of sensor.
  5. Rigid probe of aluminum, brass, copper, or stainless steel sheath.
  6. Flexible probe of aluminum, brass, copper, or stainless steel sheath and formable to a 4-inch (100-mm) radius.
  7. Length: As required by application to cover entire cross section of air tunnel.
  8. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
  9. Gasket for attachment to duct or equipment to seal penetration airtight.
  10. Conduit Connection: 1/2-inch (16-mm) trade size.



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D. Platinum RTD Outdoor Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [ETI.](#)
  - b. [WindowMaster Clearline Inc.](#)
2. 100 or 1000 ohms.
3. Temperature Range: Minus 50 to 275 deg F (Minus 45 to 135 deg C).
4. Probe: Single-point sensor with a stainless steel sheath.
5. Solar Shield: Stainless steel.
6. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
7. Conduit Connection: 1/2-inch (16-mm) trade size.

E. Platinum RTD Space Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [ETI.](#)
  - b. [WindowMaster Clearline Inc.](#)
2. 100 or 1000 ohms.
3. Temperature Range: Minus 50 to 212 deg F (Minus 45 to 100 deg C).
4. Sensor assembly shall include a temperature sensing element mounted under a flush, brushed-aluminum cover.
5. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
6. Concealed wiring connection.

F. Thermal Resistors (Thermistors): Common requirements:

1. 10,000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C.
2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
3. Performance Characteristics:
  - a. Range: Minus 50 to 275 deg F (Minus 46 to 135 deg C).
  - b. Interchangeable Accuracy: At 77 deg F (25 deg C) within 0.5 deg F (0.3 deg C).
  - c. Repeatability: Within 0.5 deg F (0.3 deg C).
  - d. Drift: Within 0.5 deg F (0.3 deg C) over 10 years.
  - e. Self-Heating: Negligible.
4. Transmitter optional, contingent on compliance with end-to-end control accuracy.

G. Thermistor, Single-Point Duct Air Temperature Sensors:



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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [ETI.](#)
    - b. [WindowMaster Clearline Inc.](#)
  2. Temperature Range: Minus 50 to 275 deg F (Minus 45 to 135 deg C).
  3. Probe: Single-point sensor with a stainless steel sheath.
  4. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches (450 mm) long.
  5. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
  6. Gasket for attachment to duct or equipment to seal penetration airtight.
  7. Conduit Connection: 1/2-inch (16-mm) trade size.
- H. Thermistor Averaging Air Temperature Sensors:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [ETI.](#)
    - b. [WindowMaster Clearline Inc.](#)
  2. Temperature Range: Minus 50 to 275 deg F (Minus 45 to 135 deg C).
  3. Multiple sensors to provide average temperature across entire length of sensor.
  4. Rigid probe of aluminum, brass, copper, or stainless steel sheath.
  5. Flexible probe of aluminum, brass, copper, or stainless steel sheath and formable to a 4-inch (100-mm) radius.
  6. Length: As required by application to cover entire cross section of air tunnel.
  7. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
  8. Gasket for attachment to duct or equipment to seal penetration airtight.
  9. Conduit Connection: 1/2-inch (16-mm) trade size.
- I. Thermistor Outdoor Air Temperature Sensors:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
    - a. [ETI.](#)
    - b. [WindowMaster Clearline Inc.](#)
  2. Temperature Range: Minus 50 to 275 deg F (Minus 45 to 135 deg C).
  3. Probe: Single-point sensor with a stainless steel sheath.
  4. Solar Shield: Stainless steel.
  5. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
  6. Conduit Connection: 1/2-inch (16-mm) trade size.



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J. Thermistor Space Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
  - a. [ETI.](#)
  - b. [WindowMaster Clearline Inc.](#)
2. Temperature Range: Minus 50 to 212 deg F (Minus 45 to 100 deg C).
3. Sensor assembly shall include a temperature sensing element mounted under a flush, brushed-aluminum cover.
4. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
5. Concealed wiring connection.

2.3 COMBINATION AIR TEMPERATURE SENSORS AND SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
1. [ETI.](#)
  2. [WindowMaster Clearline Inc.](#)
- B. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.
- C. Combination temperature sensor and switch in same instrument.
- D. Air Temperature Switch:
1. Factory preset set point of 38 deg F (3 deg C). Field-adjustable set point from 30 to 44 deg F (minus 1 to 7 deg C).
  2. Responsive to coldest 12-inch (300-mm) section of sensor length.
  3. DPST latching relay rated at 25 A and 120-V ac, with powered controller, coil, and manual rest at panel. Wire one leg to fan start circuit and other leg to signal a remote alarm.
- E. Air Temperature Sensor:
1. Temperature-averaging type over sensor length. Length to be determined by installing trade to provide uniform coverage over air tunnel. Consult manufacturer for recommendations.
  2. Platinum RTD with a value of 1000 ohms at 0 deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
  3. Accuracy: Within 0.9 deg F (0.5 deg C).
  4. Output Signal: 4 to 20 mA for connection to remote monitoring.



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5. Encase RTDs in a flexible nominal 0.375-inch- (9-mm-) diameter sheath constructed of brass.
6. Lead wires shall be 18-gage AWG copper.
7. Enclosure: NEMA 250, Type 4.

## 2.4 AIR TEMPERATURE SWITCHES

### A. Thermostat and Switch for Low Temperature Control in Duct Applications:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [ETI.](#)
  - b. [WindowMaster Clearline Inc.](#)
2. Description:
  - a. Two-position control.
  - b. Field-adjustable set point.
  - c. Manual reset.
  - d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Performance:
  - a. Operating Temperature Range: 15 to 55 deg F (Minus 9 to 13 deg C).
  - b. Temperature Differential: 5 deg F (2.8 deg C), non-adjustable and additive.
  - c. Enclosure Ambient Temperature: Minus 20 to 140 deg F (Minus 11 to 60 deg C).
  - d. Sensing Element Maximum Temperature: 250 deg F (121 deg C).
  - e. Voltage: 120-V ac.
  - f. Current: 16 FLA.
  - g. Switch Type: Two SPDT snap switches operate on coldest 12-inch (300-mm) section along element length.
4. Construction:
  - a. Vapor-Filled Sensing Element: Nominal 20 ft. (6 m) long.
  - b. Dual Temperature Scale: Fahrenheit and Celsius visible on face.
  - c. Set-Point Adjustment: Screw.
  - d. Enclosure: Painted metal, NEMA 250, Type 1.
  - e. Electrical Connections: Screw terminals.
  - f. Conduit Connection: 1/2-inch (16-mm) trade size.

### B. Thermostat and Switch for High Temperature Control in Duct Applications:



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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [ETI.](#)
  - b. [WindowMaster Clearline Inc.](#)
2. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.
3. Description:
  - a. Two-position control.
  - b. Field-adjustable set point.
  - c. Manual reset.
  - d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Performance:
  - a. Temperature Range: 100 to 160 deg F (38 to 71 deg C).
  - b. Temperature Differential: 5 deg F (2.8 deg C).
  - c. Ambient Temperature: Zero to 260 deg F (Minus 18 to 127 deg C).
  - d. Voltage: 120-V ac.
  - e. Current: 16 FLA.
  - f. Switch Type: SPDT snap switch.
5. Construction:
  - a. Sensing Element: Helical bimetal.
  - b. Enclosure: Metal, NEMA 250, Type 1.
  - c. Electrical Connections: Screw terminals.
  - d. Conduit Connection: 1/2-inch (16-mm) trade size.

## 2.5 AIR TEMPERATURE RTD TRANSMITTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  1. [ETI.](#)
  2. [WindowMaster Clearline Inc.](#)
- B. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.
- C. House electronics in NEMA 250 enclosure.
  1. Duct: Type 2.
  2. Outdoor: Type 4.



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3. Space: Type 1.
- D. Conduit Connection: 1/2-inch (16-mm) trade size.
- E. Functional Characteristics:
  1. Input:
    - a. 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
    - b. 1000-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
  2. Span (Adjustable):
    - a. Space: 40 to 90 deg F (4 to 32 deg C).
    - b. Supply Air Cooling and Heating: 40 to 120 deg F (4 to 49 deg C).
    - c. Supply Air Cooling Only: 40 to 90 deg F (4 to 32 deg C).
    - d. Supply Air Heating Only: 40 to 120 deg F (4 to 49 deg C).
    - e. Exhaust Air: 50 to 100 deg F (10 to 38 deg C).
    - f. Return Air: 50 to 100 deg F (10 to 38 deg C).
    - g. Mixed Air: Minus 40 to 140 deg F (Minus 40 to 60 deg C).
    - h. Outdoor: Minus 40 to 140 deg F (Minus 40 to 60 deg C).
  3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.
  4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F (28 deg C).
  5. Match sensor with temperature transmitter and factory calibrate together.
- F. Performance Characteristics:
  1. Calibration Accuracy: Within 0.1 percent of the span.
  2. Stability: Within 0.2 percent of the span for at least 6 months.
  3. Combined Accuracy: Within 0.5 percent.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.



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- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 TEMPERATURE INSTRUMENT APPLICATIONS

- A. Air Temperature Sensors:
  - 1. Duct,: Thermistor.
  - 2. Outdoor,: Thermistor.
  - 3. Space,: Thermistor.
- B. Air Temperature Transmitters:
  - 1. Duct,: Air temperature RTD transmitter.
  - 2. Outdoor,: Air temperature RTD transmitter.
  - 3. Space,: Air temperature RTD transmitter.

### 3.3 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- C. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.



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3.4 ELECTRICAL CONNECTIONS

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 26 28 16 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 26 05 33.13 "Conduits for Electrical Systems."

3.5 INSTALLATION OF TEMPERATURE INSTRUMENTS

A. Mounting Location:

1. Roughing In:

- a. Outline instrument mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
- b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
  - 1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
  - 2) Do not begin installation without submittal approval of mounting location.
- c. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.

- 2. Install switches and transmitters for air and liquid temperature associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.
- 3. Install liquid and steam temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
- 4. Install air temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
- 5. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.



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B. Special Mounting Requirements:

1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.
2. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.

C. Mounting Height:

1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of 42 to 72 inches (1.1 to 1.6 m) above the adjacent floor, grade, or service catwalk or platform.
  - a. Make every effort to mount at 60 inches (1500 mm).

D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

E. Installation of Space Temperature Sensor:

1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
3. In finished areas, recess electrical box within wall.
4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

F. Installation of Outdoor Air Temperature Sensor:

1. Mount sensor in a discrete location facing north.
2. Protect installed sensor from solar radiation and other influences that could impact performance.
3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.

G. Installation of Single-Point Duct Temperature Sensor:



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1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches (610 mm) in sensor length.
2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
3. Rigidly support sensor to duct and seal penetration airtight.
4. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.

H. Installation of Averaging Duct Temperature Sensor:

1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. (1.86 sq. m) and larger.
2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
4. If required to have transmitter, mount transmitter in an accessible and serviceable location.

I. Installation of Low-Limit Air Temperature Switch:

1. Install multiple low-limit switches to maintain coverage over entire cross-sectional area of air tunnel.
2. Fasten and support sensing element with manufacturer-furnished clips to keep element taut throughout entire length.
3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.
4. Install on entering side of cooling coil unless otherwise indicated on Drawings.

### 3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification and on face of ceiling directly below instruments concealed above ceilings.

### 3.7 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.



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- B. Wash and shine glazing.
- C. Polish glossy surfaces to a clean shine.

### 3.8 CHECK-OUT PROCEDURES

- A. Check installed products before continuity tests, leak tests, and calibration.
- B. Check temperature instruments for proper location and accessibility.
- C. Verify sensing element type and proper material.
- D. Verify location and length.
- E. Verify that wiring is correct and secure.

### 3.9 ADJUSTMENT, CALIBRATION, AND TESTING

#### A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

#### B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.



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2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

### 3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

C. Tests and Inspections: Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform according to manufacturer's written instruction.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

### 3.11 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.



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3.12 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include annual preventive maintenance, repair or replacement of worn or defective components, cleaning and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.13 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.
- B. Provide a complete set of instructional videos covering each product specified and installed and showing the following:
1. Software programming.
  2. Calibration and test procedures.
  3. Operation and maintenance requirements and procedures.
  4. Troubleshooting procedures.
- C. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- D. Record videos on DVD disks.
- E. Owner shall have right to make additional copies of video for internal use without paying royalties.

**END OF SECTION 23 09 23.27**



## **SECTION 23 23 00 - REFRIGERANT PIPING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Copper tube and fittings.
2. Valves and specialties.
3. Refrigerants.

#### **1.2 ACTION SUBMITTALS**

**A. Product Data: For the following:**

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Strainers.
5. Filter dryers.
6. Pressure-regulating valves.
7. Mufflers.

**B. Product Data Submittals: For each product.**

1. Submit data for each type of refrigerant piping, fitting, valve, piping specialty, and refrigerant.

**C. Delegated Design Submittals: For refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.**

**D. Shop Drawings:**

1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: 1/4 inch equals 1 foot (1:50).



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1.3 INFORMATIONAL SUBMITTALS

- A. Welding Certificates: For each welder performing shop or field welding on Project.
- B. Field Quality-Control Reports: For each field quality control test and inspection.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding, Brazing, and Fusing Qualifications."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.
- B. Prepare valves and specialties for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads and other end connections.
- C. Use the following precautions during storage:
  - 1. Maintain valve and specialty end protection.
  - 2. Store valves and specialties indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," for refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.



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- B. Comply with ASHRAE 15.
- C. Comply with ASME B31.5.
- D. Test Pressure for Refrigerant R-410A:
  - 1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: 300 psig (2068 kPa).
  - 2. Suction Tubing for Heat-Pump Applications: 535 psig (3689 kPa).
  - 3. Hot-Gas and Tubing Lines: 535 psig (3689 kPa).

## 2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B88, Type K ASTM B88M, Type A or B).
- B. Wrought-Copper Fittings, Solder Joint: ASME B16.22.
- C. Wrought-Copper Fittings, Brazed Joint: ASME B16.50.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- F. Brazing Filler Metals: AWS A5.8M/A5.8.
- G. Flexible Connectors:
  - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
  - 2. End Connections: Socket ends.
  - 3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
  - 4. Working Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
- H. Copper-Tube, Pressure-Seal-Joint Fittings for Refrigerant Piping:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [A-Gas.](#)
    - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
    - c. [ASPEN Refrigerants Inc.](#)
    - d. [Caleffi North America, Inc.](#)
    - e. [Carrier Corp.](#)
    - f. [CIMCO Refrigeration.](#)
    - g. [Conex Bänninger - USA.](#)
    - h. [Daikin America, Inc.](#)



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- i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)
- 2. Standard: UL 207; certified by UL for field installation. Certification as a UL-recognized component alone is unacceptable.
  - 3. Housing: Copper.
  - 4. O-Rings: HNBR compatible with specific refrigerant.
  - 5. Tools: Manufacturer's approved special tools.
  - 6. Minimum Rated Pressure: 700 psig (48 bar).

## 2.3 VALVES AND SPECIALTIES

### A. Diaphragm Packless Valves:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [A-Gas.](#)
  - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
  - c. [ASPEN Refrigerants Inc.](#)
  - d. [Caleffi North America, Inc.](#)
  - e. [Carrier Corp.](#)
  - f. [CIMCO Refrigeration.](#)
  - g. [Conex Banninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)
- 2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
- 3. Diaphragm: Phosphor bronze and stainless steel with stainless steel spring.
- 4. Operator: Rising stem and hand wheel.
- 5. Seat: Nylon.
- 6. End Connections: Socket, union, or flanged.
- 7. Working Pressure Rating: 500 psig (3450 kPa).
- 8. Maximum Operating Temperature: 240 deg F (116 deg C).

### B. Packed-Angle Valves:



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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [A-Gas.](#)
  - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
  - c. [ASPEN Refrigerants Inc.](#)
  - d. [Caleffi North America, Inc.](#)
  - e. [Carrier Corp.](#)
  - f. [CIMCO Refrigeration.](#)
  - g. [Conex Bänninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)
2. Body and Bonnet: Forged brass or cast bronze.
3. Packing: Molded stem, back seating, and replaceable under pressure.
4. Operator: Rising stem.
5. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
6. Seal Cap: Forged-brass or valox hex cap.
7. End Connections: Socket, union, threaded, or flanged.
8. Working Pressure Rating: 500 psig (3450 kPa).
9. Maximum Operating Temperature: 275 deg F (135 deg C).

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [A-Gas.](#)
  - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
  - c. [ASPEN Refrigerants Inc.](#)
  - d. [Caleffi North America, Inc.](#)
  - e. [Carrier Corp.](#)
  - f. [CIMCO Refrigeration.](#)
  - g. [Conex Bänninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)



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2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
4. Piston: Removable polytetrafluoroethylene seat.
5. Closing Spring: Stainless steel.
6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
7. End Connections: Socket, union, threaded, or flanged.
8. Maximum Opening Pressure: 0.50 psig (3.4 kPa).
9. Working Pressure Rating: 500 psig (3450 kPa).
10. Maximum Operating Temperature: 275 deg F (135 deg C).

D. Service Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [A-Gas.](#)
  - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
  - c. [ASPEN Refrigerants Inc.](#)
  - d. [Caleffi North America, Inc.](#)
  - e. [Carrier Corp.](#)
  - f. [CIMCO Refrigeration.](#)
  - g. [Conex Bänninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)
2. Body: Forged brass with brass cap, including key end to remove core.
3. Core: Removable ball-type check valve with stainless steel spring.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Copper spring.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 deg F (135 deg C).

E. Refrigerant Locking Caps:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [A-Gas.](#)
  - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
  - c. [ASPEN Refrigerants Inc.](#)
  - d. [Caleffi North America, Inc.](#)
  - e. [Carrier Corp.](#)
  - f. [CIMCO Refrigeration.](#)



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- g. [Conex Bänninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)
- 2. Description: Locking-type, tamper-resistant, threaded caps to protect refrigerant-charging ports from unauthorized refrigerant access and leakage.
  - 3. Material: Brass, with protective shroud or sleeve.
  - 4. Refrigerant Identification: Color-coded, refrigerant specific based on AHRI Guideline N design.
  - 5. Special Tool: For installing and unlocking.
- F. Solenoid Valves: Comply with AHRI 760 I-P (AHRI 761 SI) and UL 429; listed and labeled by an NRTL.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [A-Gas.](#)
    - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
    - c. [ASPEN Refrigerants Inc.](#)
    - d. [Caleffi North America, Inc.](#)
    - e. [Carrier Corp.](#)
    - f. [CIMCO Refrigeration.](#)
    - g. [Conex Bänninger - USA.](#)
    - h. [Daikin America, Inc.](#)
    - i. [ITT Hoffman Specialty.](#)
    - j. [SharkBite.](#)
    - k. [SMEG USA, Inc.](#)
    - l. [SpacePak, a Mestek Company.](#)
    - m. [Taco Comfort Solutions, Inc.](#)
    - n. [The Metraflex Company.](#)
    - o. [Watts.](#)
  - 2. Body and Bonnet: Plated steel.
  - 3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
  - 4. Seat: Polytetrafluoroethylene.
  - 5. End Connections: Threaded.
  - 6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-mm) conduit adapter, and 115 V ac coil.
  - 7. Working Pressure Rating: 400 psig (2760 kPa).
  - 8. Maximum Operating Temperature: 240 deg F (116 deg C).



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G. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [A-Gas.](#)
  - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
  - c. [ASPEN Refrigerants Inc.](#)
  - d. [Caleffi North America, Inc.](#)
  - e. [Carrier Corp.](#)
  - f. [CIMCO Refrigeration.](#)
  - g. [Conex Bänninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)
2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
3. Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Working Pressure Rating: 400 psig (2760 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).

H. Thermostatic Expansion Valves: Comply with AHRI 750 I-P (AHRI 751 SI).

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [A-Gas.](#)
  - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
  - c. [ASPEN Refrigerants Inc.](#)
  - d. [Caleffi North America, Inc.](#)
  - e. [Carrier Corp.](#)
  - f. [CIMCO Refrigeration.](#)
  - g. [Conex Bänninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)



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- o. [Watts.](#)
  - 2. Body, Bonnet, and Seal Cap: Forged brass or steel.
  - 3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
  - 4. Packing and Gaskets: Non-asbestos.
  - 5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
  - 6. Suction Temperature: 40 deg F (4.4 deg C).
  - 7. Superheat: Adjustable.
  - 8. Reverse-flow option (for heat-pump applications).
  - 9. End Connections: Socket, flare, or threaded union.
  - 10. Working Pressure Rating: 700 psig (4820 kPa).
- I. Straight-Type Strainers:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [A-Gas.](#)
    - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
    - c. [ASPEN Refrigerants Inc.](#)
    - d. [Caleffi North America, Inc.](#)
    - e. [Carrier Corp.](#)
    - f. [CIMCO Refrigeration.](#)
    - g. [Conex Bänninger - USA.](#)
    - h. [Daikin America, Inc.](#)
    - i. [ITT Hoffman Specialty.](#)
    - j. [SharkBite.](#)
    - k. [SMEG USA, Inc.](#)
    - l. [SpacePak, a Mestek Company.](#)
    - m. [Taco Comfort Solutions, Inc.](#)
    - n. [The Metraflex Company.](#)
    - o. [Watts.](#)
  - 2. Body: Welded steel with corrosion-resistant coating.
  - 3. Screen: 100-mesh stainless steel.
  - 4. End Connections: Socket or flare.
  - 5. Working Pressure Rating: 500 psig (3450 kPa).
  - 6. Maximum Operating Temperature: 275 deg F (135 deg C).
- J. Angle-Type Strainers:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [A-Gas.](#)
    - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
    - c. [ASPEN Refrigerants Inc.](#)
    - d. [Caleffi North America, Inc.](#)
    - e. [Carrier Corp.](#)



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- f. [CIMCO Refrigeration.](#)
  - g. [Conex Bänninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)
- 2. Body: Forged brass or cast bronze.
  - 3. Drain Plug: Brass hex plug.
  - 4. Screen: 100-mesh monel.
  - 5. End Connections: Socket or flare.
  - 6. Working Pressure Rating: 500 psig (3450 kPa).
  - 7. Maximum Operating Temperature: 275 deg F (135 deg C).
- K. Moisture/Liquid Indicators:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [A-Gas.](#)
    - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
    - c. [ASPEN Refrigerants Inc.](#)
    - d. [Caleffi North America, Inc.](#)
    - e. [Carrier Corp.](#)
    - f. [CIMCO Refrigeration.](#)
    - g. [Conex Bänninger - USA.](#)
    - h. [Daikin America, Inc.](#)
    - i. [ITT Hoffman Specialty.](#)
    - j. [SharkBite.](#)
    - k. [SMEG USA, Inc.](#)
    - l. [SpacePak, a Mestek Company.](#)
    - m. [Taco Comfort Solutions, Inc.](#)
    - n. [The Metraflex Company.](#)
    - o. [Watts.](#)
  - 2. Body: Forged brass.
  - 3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
  - 4. Indicator: Color-coded to show moisture content in parts per million (ppm).
  - 5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
  - 6. End Connections: Socket or flare.
  - 7. Working Pressure Rating: 500 psig (3450 kPa).
  - 8. Maximum Operating Temperature: 240 deg F (116 deg C).
- L. Replaceable-Core Filter Dryers: Comply with AHRI 730 I-P (AHRI 731 SI).



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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [A-Gas.](#)
  - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
  - c. [ASPEN Refrigerants Inc.](#)
  - d. [Caleffi North America, Inc.](#)
  - e. [Carrier Corp.](#)
  - f. [CIMCO Refrigeration.](#)
  - g. [Conex Bänninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)
2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless steel screws, and neoprene gaskets.
3. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
4. Desiccant Media: Activated charcoal.
5. Design: Reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig (14 kPa).
9. Working Pressure Rating: 500 psig (3450 kPa).
10. Maximum Operating Temperature: 240 deg F (116 deg C).

M. Permanent Filter Dryers: Comply with AHRI 730 I-P (AHRI 731 SI).

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [A-Gas.](#)
  - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
  - c. [ASPEN Refrigerants Inc.](#)
  - d. [Caleffi North America, Inc.](#)
  - e. [Carrier Corp.](#)
  - f. [CIMCO Refrigeration.](#)
  - g. [Conex Bänninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)



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- m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)
- 2. Body and Cover: Painted-steel shell.
  - 3. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
  - 4. Desiccant Media: Activated alumina charcoal.
  - 5. Design: Reverse flow (for heat-pump applications).
  - 6. End Connections: Socket.
  - 7. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
  - 8. Maximum Pressure Loss: 2 psig (14 kPa).
  - 9. Working Pressure Rating: 500 psig (3450 kPa).
  - 10. Maximum Operating Temperature:.
- N. Mufflers:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [A-Gas.](#)
    - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
    - c. [ASPEN Refrigerants Inc.](#)
    - d. [Caleffi North America, Inc.](#)
    - e. [Carrier Corp.](#)
    - f. [CIMCO Refrigeration.](#)
    - g. [Conex Bänninger - USA.](#)
    - h. [Daikin America, Inc.](#)
    - i. [ITT Hoffman Specialty.](#)
    - j. [SharkBite.](#)
    - k. [SMEG USA, Inc.](#)
    - l. [SpacePak, a Mestek Company.](#)
    - m. [Taco Comfort Solutions, Inc.](#)
    - n. [The Metraflex Company.](#)
    - o. [Watts.](#)
  - 2. Body: Welded steel with corrosion-resistant coating.
  - 3. End Connections: Socket or flare.
  - 4. Working Pressure Rating: 500 psig (3450 kPa).
  - 5. Maximum Operating Temperature: 275 deg F (135 deg C).
- O. Receivers: Comply with AHRI 495.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [A-Gas.](#)
    - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
    - c. [ASPEN Refrigerants Inc.](#)



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- d. [Caleffi North America, Inc.](#)
  - e. [Carrier Corp.](#)
  - f. [CIMCO Refrigeration.](#)
  - g. [Conex Bänninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)
- 2. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
  - 3. Comply with UL 207; listed and labeled by an NRTL.
  - 4. Body: Welded steel with corrosion-resistant coating.
  - 5. Tappings: Inlet, outlet, liquid-level indicator, and safety-relief valve.
  - 6. End Connections: Socket or threaded.
  - 7. Working Pressure Rating: 450 psig (3100 kPa).
  - 8. Maximum Operating Temperature: 250 deg F (121 deg C).
- P. Liquid Accumulators: Comply with AHRI 495.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
    - a. [A-Gas.](#)
    - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
    - c. [ASPEN Refrigerants Inc.](#)
    - d. [Caleffi North America, Inc.](#)
    - e. [Carrier Corp.](#)
    - f. [CIMCO Refrigeration.](#)
    - g. [Conex Bänninger - USA.](#)
    - h. [Daikin America, Inc.](#)
    - i. [ITT Hoffman Specialty.](#)
    - j. [SharkBite.](#)
    - k. [SMEG USA, Inc.](#)
    - l. [SpacePak, a Mestek Company.](#)
    - m. [Taco Comfort Solutions, Inc.](#)
    - n. [The Metraflex Company.](#)
    - o. [Watts.](#)
  - 2. Body: Welded steel with corrosion-resistant coating.
  - 3. End Connections: Socket or threaded.
  - 4. Working Pressure Rating: 500 psig (3450 kPa).
  - 5. Maximum Operating Temperature: 275 deg F (135 deg C).



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2.4 REFRIGERANTS

A. R-407C, ASHRAE 34: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [A-Gas.](#)
  - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
  - c. [ASPEN Refrigerants Inc.](#)
  - d. [Caleffi North America, Inc.](#)
  - e. [Carrier Corp.](#)
  - f. [CIMCO Refrigeration.](#)
  - g. [Conex Bänninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)

B. R-410A, ASHRAE 34: Pentafluoroethane/Difluoromethane.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - a. [A-Gas.](#)
  - b. [AGRAMKOW - North America Division / SCHENCK USA CORP.](#)
  - c. [ASPEN Refrigerants Inc.](#)
  - d. [Caleffi North America, Inc.](#)
  - e. [Carrier Corp.](#)
  - f. [CIMCO Refrigeration.](#)
  - g. [Conex Bänninger - USA.](#)
  - h. [Daikin America, Inc.](#)
  - i. [ITT Hoffman Specialty.](#)
  - j. [SharkBite.](#)
  - k. [SMEG USA, Inc.](#)
  - l. [SpacePak, a Mestek Company.](#)
  - m. [Taco Comfort Solutions, Inc.](#)
  - n. [The Metraflex Company.](#)
  - o. [Watts.](#)



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PART 3 - EXECUTION

3.1 PIPING APPLICATION SCHEDULES

- A. Refrigerant: R-410A
- B. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 4 (DN 100) and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- C. Safety-Relief-Valve Discharge Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, Copper: Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
  - 1. Install valve so diaphragm case is warmer than bulb.
  - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
  - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety-relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside in accordance with ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.



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- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
  - 1. Solenoid valves.
  - 2. Thermostatic expansion valves.
  - 3. Hot-gas bypass valves.
  - 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.
- N. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to authority having jurisdiction.

### 3.3 INSTALLATION OF PIPING, GENERAL

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping in accordance with ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.



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- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 13 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- L. Install refrigerant piping in protective conduit where installed belowground.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Install traps and double risers to entrain oil in vertical runs.
  - 4. Liquid lines may be installed level.
- O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
  - 1. Shot blast the interior of piping.
  - 2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
  - 3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
  - 4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
  - 5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
  - 6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
- Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- R. Identify refrigerant piping and valves in accordance with Section 23 05 53 "Identification for HVAC Piping and Equipment."
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."



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- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 "Escutcheons for HVAC Piping."

### 3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints in accordance with AWS BRH, "Brazing Handbook," Ch. 35, "Pipe and Tubing."
  - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
  - 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.
- F. Threaded Joints: Thread steel pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
- H. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12.
- I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.



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3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic restraints in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 ft. (6 m) long.
  - 2. Roller hangers and spring hangers for individual horizontal runs 20 ft. (6 m) or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 ft. (6 m) or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping within 12 inches (300 mm) of each fitting.
- E. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
  - 1. Comply with ASME B31.5, Chapter VI.
  - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
  - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
    - a. Fill system with nitrogen to the required test pressure.
    - b. System must maintain test pressure at the manifold gauge throughout duration of test.
    - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- C. Prepare test and inspection reports.



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3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
1. Install core in filter dryers after leak test but before evacuation.
  2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
  3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
  4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Open shutoff valves in condenser water circuit.
  2. Verify that compressor oil level is correct.
  3. Open compressor suction and discharge valves.
  4. Open refrigerant valves but not bypass valves that are used for other purposes.
  5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

**END OF SECTION 23 23 00**



## **SECTION 23 31 13 - METAL DUCTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Single-wall rectangular ducts and fittings.
  - 2. Double-wall rectangular ducts and fittings.
  - 3. Single-wall round ducts and fittings.
  - 4. Sheet metal materials.
  - 5. Duct liner.
  - 6. Sealants and gaskets.
  - 7. Hangers and supports.
  - 8. Seismic-restraint devices.

#### **1.3 DEFINITIONS**

- A. OSHPD: Office of Statewide Health Planning and Development (State of California).

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of the following products:
  - 1. Liners and adhesives.
  - 2. Sealants and gaskets.
  - 3. Seismic-restraint devices.
- B. Sustainable Design Submittals:
  - 1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
  - 2. Product Data: For adhesives, indicating VOC content.
  - 3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
  - 4. Product Data: For sealants, indicating VOC content.



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5. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For antimicrobial coatings, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Dimensions of all duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
13. .

D. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Welding certificates.
- C. Field quality-control reports.



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1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
  2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
  3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7. SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
1. Seismic Hazard Level (SHL): **C**
  2. Connection Level: **2**.
  3. .
- C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.



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2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
1. Construct ducts of galvanized sheet steel unless otherwise indicated.
  2. For ducts exposed to weather, construct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.
- B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. For ducts with longest side less than 36 inches (914 mm), select joint types in accordance with Figure 2-1.
  2. For ducts with longest side 36 inches (914 mm) or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
  3. Where specified for specific applications, all joints shall be welded.
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.
1. Where specified for specific applications, all joints shall be welded.
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. McGill AirFlow LLC.
  2. MKT Metal Manufacturing.
  3. Set Duct Manufacturing.



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4. Sheet Metal Connectors, Inc.
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for clear internal dimensions of the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
  1. Construct ducts of galvanized sheet steel unless otherwise indicated.
  2. For ducts exposed to weather, construct outer duct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.
- D. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  1. For ducts with longest side less than 36 inches (914 mm), select joint types in accordance with Figure 2-1.
  2. For ducts with longest side 36 inches (914 mm) or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
  3. Where specified for specific applications, all joints shall be welded.
- E. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.
  1. Where specified for specific applications, all joints shall be welded.
- F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
  2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
  3. Coat insulation with antimicrobial coating.
  4. Cover insulation with polyester film complying with UL 181, Class 1.
- G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.



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1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F (0.034 W/m x K) at 75 deg F (24 deg C) mean temperature.

- H. Inner Duct: Minimum 24-gauge (0.7-mm) perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.

## 2.4 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Construct ducts of galvanized sheet steel unless otherwise indicated.
  2. For ducts exposed to weather, construct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.
  3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ductmate Industries, Inc.
    - b. Elgen Manufacturing.
    - c. Linx Industries (formerly Lindab).
    - d. McGill AirFlow LLC.
    - e. MKT Metal Manufacturing.
    - f. Nordfab Ducting.
    - g. SEMCO, LLC; part of FlaktGroup.
    - h. Set Duct Manufacturing.
    - i. Sheet Metal Connectors, Inc.
    - j. Spiral Manufacturing Co., Inc.
    - k. Stamped Fittings Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Transverse Joints in Ducts Larger Than 60 (1524) Inches (mm) in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."



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1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
  2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.5 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
1. Galvanized Coating Designation: G90 (Z275).
  2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A653/A653M.
1. Galvanized Coating Designation: G90 (Z275).
  2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils (0.10 mm) thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil (0.025 mm) thick on opposite surface.
  3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.
- D. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.
- E. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.
- F. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- G. Factory- or Shop-Applied Antimicrobial Coating:
1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.



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2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested in accordance with ASTM D3363.
  4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
  5. Shop-Applied Coating Color: Black.
  6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- H. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- I. Tie Rods: Galvanized steel, 1/4-inch- (6-mm-) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch- (10-mm-) minimum diameter for lengths longer than 36 inches (900 mm).

## 2.6 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation; Saint-Gobain North America.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. Owens Corning.
  2. Maximum Thermal Conductivity:
    - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
    - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K) at 75 deg F (24 deg C) mean temperature.
  3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.
    - a. Verify adhesive has a VOC content of 80 g/L or less.



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- b. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.
- B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 2. Aeroflex USA.
    - a. Armacell LLC.
    - b. Ductmate Industries, Inc.
    - c. K-Flex USA.
  - 3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
  - 4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
    - a. Verify adhesive has a VOC content of 80 g/L or less.
    - b. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.
- C. Fiberglass-Free Duct Liner: Made from partially recycled cotton or polyester products and containing no fiberglass. Airstream surface overlaid with fire-resistant facing to prevent surface erosion by airstream, complying with NFPA 90A or NFPA 90B. Treat natural-fiber products with antimicrobial coating.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Acoustical Surfaces, Inc.
    - b. Bonded Logic, Inc.
    - c. Ductmate Industries, Inc.
  - 2. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F (0.034 W/m x K) at 75 deg F (24 deg C) mean temperature when tested in accordance with ASTM C518.



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3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with ASTM E84; certified by an NRTL.
4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
  - a. Verify adhesive has a VOC content of 80 g/L or less.
  - b. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.

D. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) in diameter.

E. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s) or greater.
7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  - a. Fan discharges.



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- b. Intervals of lined duct preceding unlined duct.
  - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm (12.7 m/s) or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
- a. Sheet Metal Inner Duct Perforations: 3/32-inch (2.4-mm) diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.7 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
- 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
  - 2. Tape Width: 3 inches (76 mm).
  - 3. Sealant: Modified styrene acrylic.
  - 4. Water resistant.
  - 5. Mold and mildew resistant.
  - 6. Maximum Static-Pressure Class: 10 inch wg (2500 Pa), positive and negative.
  - 7. Service: Indoor and outdoor.
  - 8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
  - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
  - 10. Verify sealant has a VOC content of 420 g/L or less.
  - 11. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.
- C. Water-Based Joint and Seam Sealant:
- 1. Application Method: Brush on.
  - 2. Solids Content: Minimum 65 percent.



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3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Verify sealant has a VOC content of 420 g/L or less.
9. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.
10. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. Verify sealant has a VOC content of 420 g/L or less.
7. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:



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1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.8 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.
- F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
  1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## 2.9 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. B-line; Eaton, Electrical Sector.
  2. CADDY; nVent.
  3. Ductmate Industries, Inc.
  4. Elgen Manufacturing.
  5. Hilti, Inc.
  6. Kinetics Noise Control, Inc.
  7. Mason Industries, Inc.



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- 8. Unistrut; Atkore International.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
  - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A603, galvanized -steel cables with end connections made of galvanized-steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested in accordance with ASTM E488/E488M.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.
- B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts in maximum practical lengths with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.



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- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).
- J. Install fire, combination fire/smoke, and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.
- K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
- M. Elbows: Use long-radius elbows wherever they fit.
  - 1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
  - 2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches (300 mm) and smaller and a minimum of five segments for 14 inches (350 mm) and larger.
- N. Branch Connections: Use lateral or conical branch connections.

### 3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.



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- D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.3 DUCTWORK EXPOSED TO WEATHER

- A. All external joints are to be welded. Seal all openings to provide weatherproof construction.
- B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.
- C. Single Wall:
  - 1. Ductwork shall be Type 304 stainless steel.
  - 2. Ductwork shall be galvanized steel.
    - a. If duct outer surface is uninsulated, protect outer surface with suitable paint. Paint materials and application requirements are specified in Section 09 91 13 "Exterior Painting."
  - 3. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 23 07 13 "Duct Insulation."
- D. Double Wall:
  - 1. Ductwork shall comply with requirements in "Double-Wall Rectangular Ducts and Fittings" or "Double-Wall Round Ducts and Fittings" Article.
  - 2. Ductwork outer wall shall be Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.
  - 3. Provide interstitial insulation.

### 3.4 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. Outdoor, Supply-Air Ducts: Seal Class A.
  - 3. Outdoor, Exhaust Ducts: Seal Class C.
  - 4. Outdoor, Return-Air Ducts: Seal Class C.



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5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  1. Where practical, install concrete inserts before placing concrete.
  2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
  5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1220 mm) of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.



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3.6 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." ASCE/SEI 7.
  - 1. Space lateral supports a maximum of 40 (12) feet (m) o.c., and longitudinal supports a maximum of 80 (24) feet (m) o.c.
  - 2. Brace a change of direction longer than 12 feet (3.7 m).
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.7 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.



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3.8 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
  - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
  - 2. Test the following systems:
    - a. Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
    - b. Supply Ducts with a Pressure Class of 2- (500) Inch wg (Pa) or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - c. Return Ducts with a Pressure Class of 2- (500) Inch wg (Pa) or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - d. Exhaust Ducts with a Pressure Class of 2- (500) Inch wg (Pa) or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - e. Outdoor-Air Ducts with a Pressure Class of 2- (500) Inch wg (Pa) or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
  - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  - 4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
  - 5. Test for leaks before applying external insulation.
  - 6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
  - 7. Give seven days' advance notice for testing.



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C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
  - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. For cleaning of existing ductwork, see Section 23 01 30.52 "Existing HVAC Air Distribution System Cleaning."

C. Use duct cleaning methodology as indicated in NADCA ACR.

D. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

E. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

F. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.



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3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

G. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.11 STARTUP

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.12 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
  2. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.
  3. .
- B. Supply Ducts:



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1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units  
Insert equipment:
  - a. Pressure Class: Positive 2- (500) inch wg (Pa).
  - b. Minimum SMACNA Seal Class: B.
  - c. SMACNA Leakage Class for Rectangular: 16.
  - d. SMACNA Leakage Class for Round and Flat Oval: 8.
2. Ducts Connected to Constant-Volume Air-Handling Units:
  - a. Pressure Class: Positive 2- (500) inch wg (Pa).
  - b. Minimum SMACNA Seal Class: B.
  - c. SMACNA Leakage Class for Rectangular: 16.
  - d. SMACNA Leakage Class for Round and Flat Oval: 8.
3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
  - a. Pressure Class: Positive 3- (750) inch wg (Pa).
  - b. Minimum SMACNA Seal Class: B.
  - c. SMACNA Leakage Class for Rectangular: 8.
  - d. SMACNA Leakage Class for Round and Flat Oval: 4.
4. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive 2- (500) inch wg (Pa).
  - b. Minimum SMACNA Seal Class: B.
  - c. SMACNA Leakage Class for Rectangular: 16.
  - d. SMACNA Leakage Class for Round and Flat Oval: 8.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
  - a. Pressure Class: Positive or negative 2- (500) inch wg (Pa).
  - b. Minimum SMACNA Seal Class: B.
  - c. SMACNA Leakage Class for Rectangular: 16.
  - d. SMACNA Leakage Class for Round and Flat Oval: 8.
2. Ducts Connected to Air-Handling Units:
  - a. Pressure Class: Positive or negative 2- (500) inch wg (Pa).
  - b. Minimum SMACNA Seal Class: B.
  - c. SMACNA Leakage Class for Rectangular: 16.
  - d. SMACNA Leakage Class for Round and Flat Oval: 8.
3. Ducts Connected to Equipment Not Listed above:
  - a. Pressure Class: Positive or negative 2- (500) inch wg (Pa).
  - b. Minimum SMACNA Seal Class: B.
  - c. SMACNA Leakage Class for Rectangular: 16.
  - d. SMACNA Leakage Class for Round and Flat Oval: 8.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
  - a. Pressure Class: Negative 2- (500) inch wg (Pa).



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- b. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.
    - c. SMACNA Leakage Class for Rectangular: 16.
    - d. SMACNA Leakage Class for Round and Flat Oval: 8.
  - 2. Ducts Connected to Equipment Not Listed above:
    - a. Pressure Class: Positive or negative 2- (500) inch wg (Pa).
    - b. Minimum SMACNA Seal Class: B if negative pressure; A if positive pressure.
    - c. SMACNA Leakage Class for Rectangular: 16.
    - d. SMACNA Leakage Class for Round and Flat Oval: 8.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
  - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive or negative inch wg (Pa).
    - b. Minimum SMACNA Seal Class: B.
    - c. SMACNA Leakage Class for Rectangular: 16.
    - d. SMACNA Leakage Class for Round and Flat Oval: 8.
  - 2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2- (500) inch wg (Pa).
    - b. Minimum SMACNA Seal Class: B.
    - c. SMACNA Leakage Class for Rectangular: 8.
    - d. SMACNA Leakage Class for Round and Flat Oval: 8.
  - 3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2- (500) inch wg (Pa).
    - b. Minimum SMACNA Seal Class: B.
    - c. SMACNA Leakage Class for Rectangular: 16.
    - d. SMACNA Leakage Class for Round and Flat Oval: 8.
- F. Intermediate Reinforcement:
  - 1. Galvanized-Steel Ducts: Galvanized steel.
  - 2. PVC-Coated Ducts:
    - a. Exposed to Airstream: Match duct material.
    - b. Not Exposed to Airstream: Match duct material.
  - 3. Stainless-Steel Ducts:
    - a. Exposed to Airstream: Match duct material.
    - b. Not Exposed to Airstream: Match duct material.
  - 4. Aluminum Ducts: Aluminum.
- G. Liner:
  - 1. Supply-Air Ducts: Fibrous glass, Type I Flexible elastomeric Natural fiber, 1 (25) inch(es) (mm) thick.



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2. Return-Air Ducts: Fibrous glass, Type I Flexible elastomeric Natural fiber, 1 (25) inch(es) (mm) thick.
3. Supply Fan Plenums: Fibrous glass, Type II Flexible elastomeric Natural fiber, 1 (25) inch(es) (mm) thick.
4. Return- and Exhaust-Fan Plenums: Fibrous glass, Type II Flexible elastomeric Natural fiber, 1 inches (mm) thick.
5. Transfer Ducts: Fibrous glass, Type I Flexible elastomeric Natural fiber, 1 (25) inch(es) (mm) thick.

H. Double-Wall Duct Interstitial Insulation:

1. Supply-Air Ducts: 1 (25) inch(es) (mm) thick.
2. Return-Air Ducts: 1 (25) inch(es) (mm) thick.

I. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
  - a. Velocity 1000 fpm (5 m/s) or Lower:
    - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
    - 2) Mitered Type RE 4 without vanes.
  - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
    - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
  - c. Velocity 1500 fpm (7.6 m/s) or Higher:
    - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
  - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."



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- a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
  - 1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
  - 2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
  - 3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
  - 4) Radius-to Diameter Ratio: 1.5.
- b. Round Elbows, 12 (305) Inches (mm) and Smaller in Diameter: Stamped or pleated.
- c. Round Elbows, 14 (356) Inches (mm) and Larger in Diameter: Welded.

J. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry.
  - b. Rectangular Main to Round Branch: Conical spin in.
- 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
  - a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
  - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
  - c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

**END OF SECTION 23 31 13**



## **SECTION 23 33 00 - AIR DUCT ACCESSORIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Manual volume dampers.
  - 2. Control dampers.
  - 3. Combination fire and smoke dampers.
  - 4. Flange connectors.
  - 5. Duct silencers.
  - 6. Turning vanes.
  - 7. Remote damper operators.
  - 8. Duct-mounted access doors.
  - 9. Duct access panel assemblies.
  - 10. Flexible connectors.
  - 11. Duct accessory hardware.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. For all accessories specified, include construction details, dimensions, materials, finishes, bearings and compliance with applicable codes.
  - 2. Performance: Show compliance with pressure drops or specific requirements noted.
  - 3. Provide manufacturer's installation instructions.
  - 4. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and



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method of field assembly into duct systems and other construction. Include the following:

- a. Special fittings.
- b. Manual volume damper installations.
- c. Control-damper installations.
- d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
- e. Duct security bars.
- f. Include diagrams for power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.
- B. Source quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- C. Comply with AMCA 500-D testing for damper rating.
- D. Demonstrate resetting of fire dampers to authorities having jurisdiction and Owner's representatives.
- E. Fire and smoke dampers shall be approved by the New York City Board of Standards and Appeals



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2.2 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

2.3 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Air Balance; a division of MESTEK, Inc.
    - b. American Warming and Ventilating; a Mestek Architectural Group company.
    - c. McGill AirFlow LLC.
    - d. Pottorff.
    - e. Ruskin Company.
    - f. Vent Products Co., Inc.
  2. Performance:
    - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. (203 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
  3. Construction:
    - a. Linkage out of airstream.
    - b. Suitable for horizontal or vertical airflow applications.
  4. Frames:
    - a. Hat-shaped, 16-gauge- (1.6-mm-) thick, galvanized sheet steel.
    - b. Mitered and welded corners.
    - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
  5. Blades:
    - a. Single blade up to 6 inches blade width; multiple blades for width over 6 inches..
    - b. Opposed-blade design for multiple blades dampers..
    - c. Stiffen damper blades for stability.
    - d. Galvanized steel; 16 gauge (1.6 mm) thick.
  6. Blade Axles: Galvanized steel.
  7. Bearings:
    - a. Oil-impregnated bronze.
    - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
  8. Tie Bars and Brackets: Galvanized steel.



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9. Locking device to hold damper blades in a fixed position without vibration.

B. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Air Balance; a division of MESTEK, Inc.
  - b. American Warming and Ventilating; a Mestek Architectural Group company.
  - c. McGill AirFlow LLC.
  - d. Pottorff.
  - e. Ruskin Company.
  - f. Vent Products Co., Inc.
2. Performance:
  - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. (203 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
3. Construction:
  - a. Linkage out of airstream.
  - b. Suitable for horizontal or vertical airflow applications.
4. Frames:
  - a. Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels.
  - b. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
  - a. Single blade up to 6 inches blade width; multiple blades for width over 6 inches..
  - b. Opposed-blade design for multiple blades dampers.
  - c. Stiffen damper blades for stability.
  - d. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
  - e. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.
6. Blade Axles: Galvanized steel.
7. Bearings:
  - a. Oil-impregnated bronze.
  - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
8. Tie Bars and Brackets: Aluminum.
9. Locking device to hold damper blades in a fixed position without vibration.

C. Jackshaft:

1. Size: diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.



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3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle, made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

## 2.4 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a Mestek Architectural Group company.
2. Arrow United Industries.
3. Duro Dyne Inc.
4. McGill AirFlow LLC.
5. Pottorff.
6. Ruskin Company.
7. Vent Products Co., Inc.
8. Young Regulator Company.

B. General Requirements:

1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

C. Performance:

1. Leakage:
  - a. Class I: Leakage shall not exceed 4 cfm/sq. ft. (20 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
2. Pressure Drop: 0.05 inch wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500-D, Figure 5.3.
3. Velocity: Up to 3000 fpm (15 m/s).
4. Temperature: Minus 25 to plus 180 deg F (Minus 32 to plus 83 deg C).
5. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

D. Construction:



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1. Linkage out of airstream.
2. Suitable for horizontal or vertical airflow applications.
3. Frames:
  - a. Hat, U, or angle shaped.
  - b. 0.08-inch- (2.0-mm-) thick extruded aluminum or 16-gauge- (1.6-mm-) thick, galvanized sheet steel.
  - c. Mitered and welded or Interlocking, gusseted corners.
  - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
  - a. Multiple blade with maximum blade width of 8 inches (200 mm).
  - b. Parallel and Opposed-blade design.
  - c. Galvanized steel.
  - d. 16-gauge- (1.6-mm-) thick single skin.
5. Blade Edging Seals:
  - a. Replaceable Closed-cell neoprene.
  - b. Inflatable seal blade edging, or replaceable rubber seals.
6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch (13-mm) diameter; galvanized steel..
8. Blade-Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.
9. Bearings:
  - a. Oil-impregnated bronze.
  - b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
  - c. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.

E. Damper Actuator - Electric:

1. Electric – As indicated in schedules on drawings.
2. UL 873, plenum rated.
3. Two position or Fully modulatingas indicated in schedules on drawings.
  - a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
  - b. Minimum 90-degree drive rotation.
4. Clockwise or counterclockwise drive rotation as required for application.
5. Environmental Operating Range:
  - a. Temperature: Minus 40 to plus 130 deg F ((Minus 40 to plus 55 deg C)).
  - b. Humidity: 5 to 95 percent relative humidity noncondensing.
6. Environmental enclosure: NEMA 2.
7. Actuator to be factory mounted and provided with a single-point wiring connection.



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F. Controllers, Electrical Devices, and Wiring:

1. Comply with requirements for electrical devices and connections specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."
2. Electrical Connection: As indicated in schedule on drawings. .

2.5 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance; a division of MESTEK, Inc.
2. Pottorff.
3. Ruskin Company.

B. General Requirements:

1. Label to indicate conformance to UL 555 and UL 555S by an NRTL.
2. Label to indicate conformance to NFPA 80 and NFPA 90A by an NRTL.
3. Unless otherwise indicated, use parallel-blade configuration.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 3000 fpm (10 m/s) velocity.

D. Fire Rating: 1-1/2 hours and 3 hours.

E. Performance:

1. Leakage:
  - a. Class I: Leakage shall not exceed 4 cfm/sq. ft. (20 L/s/ per sq. m) against 1-inch wg (250-Pa) differential static pressure.
2. Pressure Drop: 0.05 in. wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500-D, Figure 5.3.
3. Velocity: Up to 3000 fpm (15 m/s).
4. Temperature: Minus 25 to plus 180 deg F (Minus 32 to plus 83 deg C).
5. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

F. Construction:

1. Suitable for horizontal or vertical airflow applications.
2. Linkage out of airstream.
3. Frame:
  - a. Hat shaped.
  - b. Galvanized sheet steel, with interlocking, gusseted or mechanically attached corners.



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- c. Gauge is to be in accordance with UL listing.
- 4. Blades:
  - a. Roll-formed, horizontal, galvanized sheet steel.
  - b. Maximum width and gauge in accordance with UL listing.
- 5. Blade Edging Seals:
  - a. Silicone rubber.
- 6. Blade Jamb Seal: Flexible stainless steel, compression type.
- 7. Blade Axles: 1/2-inch- (13-mm-) diameter;; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of airstream.
- 8. Bearings:
  - a. Oil-impregnated bronze.
- G. Mounting Sleeve (where required):
  - 1. Factory installed, galvanized sheet steel.
  - 2. Length to suit wall or floor application with factory-furnished silicone caulking.
  - 3. Gauge in accordance with UL listing.
- H. Heat-Responsive Device:
  - 1. Replaceable, 165 deg F rated, fusible links.
  - 2. Electric resettable device and switch package, factory installed, rated.
- I. Master control panel for use in dynamic smoke-management systems.
- J. Damper Actuator - Electric:
  - 1. Electric – As indicated in schedules on drawings..
  - 2. UL 873, plenum rated.
  - 3. Designed to operate in smoke-control systems complying with UL 555S requirements.
  - 4. Two position with fail-safe spring return.
    - a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
    - b. Maximum 15-second full-stroke closure.
    - c. Minimum 90-degree drive rotation.
  - 5. Clockwise or counterclockwise drive rotation as required for application.
  - 6. Environmental Operating Range:
    - a. Temperature: Minus 40 to plus 130 deg F ((Minus 40 to plus 55 deg C)).
    - b. Humidity: 5 to 95 percent relative humidity noncondensing.
  - 7. Environmental Enclosure: NEMA 2.
  - 8. Actuator to be factory mounted and provided with single-point wiring connection.



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K. Controllers, Electrical Devices, and Wiring:

1. Comply with requirements for electrical devices and connections specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."
2. Electrical Connection: As indicated in schedules on drawings..

L. Accessories:

1. Auxiliary switches for position indication.
2. Momentary test switch, damper mounted.
3. Smoke Detector: All smoke detectors, where indicated in schedules on drawings, shall be addressable type, provide by Fire Alarm, installed by mechanical contractor and wired by electrical contractor.

2.6 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. DynAir; a Carlisle Company.
4. Elgen Manufacturing.
5. Ward Industries; a brand of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gauge and Shape: Match connecting ductwork.

2.7 DUCT SILENCERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Industrial Noise Controls, Inc.
2. McGill AirFlow LLC.
3. Semco.
4. Vibro-Acoustics.

B. General Requirements:

1. Factory fabricated.



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2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
  3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
  4. Bearing AMCA's Certified Ratings Seal for prefabricated silencer sound and air performance.
- C. Shape:
1. Rectangular straight with splitters or baffles.
  2. Round straight with center bodies or pods.
  3. Rectangular elbow with splitters or baffles.
  4. Round elbow with center bodies or pods.
  5. Rectangular transitional with splitters or baffles.
- D. Rectangular Silencer Outer Casing: ASTM A653/A653M, G90 (Z275), galvanized sheet steel, 0.034 inch (0.85 mm) thick.
- E. Round Silencer Outer Casing: ASTM A653/A653M, G90 (Z275), galvanized sheet steel.
1. Sheet Metal Thickness for Units up to 24 Inches (600 mm) in Diameter: 22 gauge (0.85 mm) thick.
  2. Sheet Metal Thickness for Units 26 through 40 Inches (660 through 1000 mm) in Diameter: 20 gauge (1.02 mm) thick.
  3. Sheet Metal Thickness for Units 42 through 52 Inches (1060 through 1300 mm) in Diameter: 18 gauge (1.3 mm) thick.
  4. Sheet Metal Thickness for Units 54 through 60 Inches (1370 through 1500 mm) in Diameter: 16 gauge (1.62 mm) thick.
- F. Inner Casing and Baffles: ASTM A653/A653M, G90 (Z275) galvanized sheet metal, 22 gauge ((0.85 mm)) thick, and with 1/8-inch- (3-mm-) diameter perforations.
- G. Special Construction:
1. Suitable for outdoor use where indicated on drawings.
- H. Connection Sizes: As indicted in schedule on drawings.
- I. Principal Sound-Absorbing Mechanism:
1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
  2. Film-lined type with fill material.
    - a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.
    - b. Erosion Barrier: Polymer bag enclosing fill, heat-sealed before assembly.



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3. Lining: Mylar or Tedlar.

J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Joints: Lock formed and sealed.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

K. Accessories:

1. Factory-installed end caps to prevent contamination during shipping.

L. Source Quality Control:

1. Test in accordance with ASTM E477.

M. Capacities and Characteristics:

1. As indicated in schedule on drawings.

## 2.8 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

E. Vane Construction:



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1. Double wall.

## 2.9 MANUAL REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. DynAir; a Carlisle Company.
  2. METALAIRE, Inc.
  3. United Enertech.
  4. Young Regulator Company.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass.
- D. Cable: Stainless steel.
- E. Wall-Box Mounting: Recessed or Surface.
- F. Wall-Box Cover-Plate Material: Stainless steel.

## 2.10 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. American Warming and Ventilating; a division of Mestek, Inc.
  2. Ductmate Industries, Inc.
  3. McGill AirFlow LLC.
  4. Pottorff.
  5. Ventfabrics, Inc.
  6. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."
  1. Door:
    - a. Double wall, rectangular.
    - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    - c. 24-gauge- (0.70-mm-) thick galvanized steel door panel.
    - d. Hinges and Latches: 2-by-2-inch (50-by-50-mm) butt or piano hinge and cam latches.
    - e. Fabricate doors airtight and suitable for duct pressure class.



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2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
  - a. 24-gauge- (0.70-mm-) thick galvanized steel or.
3. Number of Hinges and Locks:
  - a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
  - b. Access Doors up to 18 Inches (460 mm) Square: Continuous and two sash locks.
  - c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Continuous and two compression latches with outside and inside handles.
  - d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Continuous and two compression latches with outside and inside handles.

#### 2.11 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Ductmate Industries, Inc.
  2. Flame Gard, Inc.
  3. 3M
- B. Access panels used in cooking applications:
  1. Labeled compliant to NFPA 96 for grease duct access doors.
  2. Labeled in accordance with UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 16-gauge (1.6-mm) carbon steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96, grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F (1093 deg C).
- F. Minimum Pressure Rating: 10 inches wg (2500 Pa) positive or negative.

#### 2.12 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. Ventfabrics, Inc.
  4. Ward Industries; a brand of Hart & Cooley, Inc.



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- B. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Materials: Flame-retardant or noncombustible fabrics.
- E. Coatings and Adhesives: Comply with UL 181, Class 1.
- F. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.
- G. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1. Minimum Weight: 30 oz./sq. yd. (880 g/sq. m).
  - 2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
- H. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
  - 1. Minimum Weight:
  - 2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
  - 3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).
- I. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
  - 1. Minimum Weight: 16 oz./sq. yd. (542 g/sq. m).
  - 2. Tensile Strength: 285 lbf/inch (50 N/mm) in the warp and 185 lbf/inch (32 N/mm) in the filling.
  - 3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).
- J. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
  - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
  - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.



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4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

2.13 DUCT ACCESSORY HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. CL WARD & Family Inc.
  2. Ductmate Industries, Inc.
  3. Duro Dyne Inc.
  4. DynAir; a Carlisle Company.
  5. Elgen Manufacturing.
  6. Hardcast; a Carlisle Company.
  7. United Enertech.
  8. Ventfabrics, Inc.
  9. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- C. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.14 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
  1. Galvanized Coating Designation: G90 (Z275).
  2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and No. 2B finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B221 (ASTM B221M), Alloy 6063, Temper T6.



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- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.
- C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.
- E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  - 1. Install steel volume dampers at the following locations
    - a. At all splits, except grease exhaust ducts.
    - b. In ducts serving single supply, return, outside air, and exhaust outlets.
    - c. In open return ducts above ceiling.
    - d. In ducts connecting to a common plenum.
    - e. Where indicated on drawings and in details.
    - f. Where required for balancing..
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.
- H. Install fire and smoke dampers in accordance with UL listing.



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- I. Connect ducts to duct silencers rigidly.
- J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. On both sides of duct coils.
  - 2. Upstream from duct filters.
  - 3. At outdoor-air intakes and mixed-air plenums.
  - 4. At drain pans and seals.
  - 5. Downstream from control dampers, and equipment.
  - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  - 7. For grease ducts, install at locations and spacing as required by NFPA 96.
  - 8. Control devices requiring inspection.
  - 9. Elsewhere as indicated.
- K. Install access doors with swing against duct static pressure.
- L. Access Door Sizes:
  - 1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
  - 2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
  - 3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
  - 4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
  - 5. Body Access: 25 by 14 inches (635 by 355 mm).
  - 6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).
- M. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- N. Install flexible connectors to connect ducts to equipment.
- O. For fans developing static pressures of 5 inches wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- P. Install duct test holes where required for testing and balancing purposes.
- Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

### 3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:



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1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5. Operate remote damper operators to verify full range of movement of operator and damper.

**END OF SECTION 23 33 00**



## **SECTION 23 33 46 - FLEXIBLE DUCTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Non-insulated flexible ducts.
  - 2. Insulated flexible ducts.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
  - 1. Product data showing compliance with ASHRAE 62.1.
  - 2. Product Data: For adhesives and sealants, indicating VOC content.
  - 3. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For flexible ducts.
  - 1. Include plans showing locations and mounting and attachment details.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.



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PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."
- D. Comply with ASTM E96/E96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 NON-INSULATED FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. [Air Distribution Concepts, Inc.](#)
  - 2. [BaseAire.](#)
  - 3. [Builder's Best, Inc.](#)
  - 4. [Construction Solutions.](#)
  - 5. [Fabric Duct Systems, Inc.](#)
  - 6. [Flexible Specialty Products.](#)
  - 7. [Hart & Cooley LLC.](#)
  - 8. [InOvate Technologies, Inc.](#)
  - 9. [KE Fibertec NA, Inc.](#)
  - 10. [MKT Metal Manufacturing.](#)
  - 11. [Nordfab LLC.](#)
  - 12. [NTI Global.](#)
  - 13. [Powered Aire, Inc.](#)
  - 14. [Prihoda North America.](#)
  - 15. [Schauenburg Flexadux Corp.](#)
  - 16. [Spunstrand Inc.](#)
  - 17. [Thermaflex.](#)
- B. Non-Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
  - 1. Pressure Rating: 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
  - 2. Maximum Air Velocity: 4000 fpm (20 m/s).
  - 3. Temperature Range: Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C).



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- C. Non-Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil.
1. Pressure Rating: 8-inch wg (2280 Pa) positive or negative.
  2. Maximum Air Velocity: 5000 fpm (25 m/s).
  3. Temperature Range: Minus 100 to plus 435 deg F (Minus 73 to plus 224 deg C).

2.3 INSULATED FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. [Air Distribution Concepts, Inc.](#)
  2. [BaseAire.](#)
  3. [Builder's Best, Inc.](#)
  4. [Construction Solutions.](#)
  5. [Fabric Duct Systems, Inc.](#)
  6. [Flexible Specialty Products.](#)
  7. [Hart & Cooley LLC.](#)
  8. [InOvate Technologies, Inc.](#)
  9. [KE Fibertec NA, Inc.](#)
  10. [MKT Metal Manufacturing.](#)
  11. [Nordfab LLC.](#)
  12. [NTI Global.](#)
  13. [Powered Aire, Inc.](#)
  14. [Prihoda North America.](#)
  15. [Schauenburg Flexadux Corp.](#)
  16. [Spunstrand Inc.](#)
  17. [Thermaflex.](#)
- B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
1. Pressure Rating: 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
  2. Maximum Air Velocity: 4000 fpm (20 m/s).
  3. Temperature Range: Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C).
  4. Insulation R-Value: R4.2.
- C. Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil; fibrous-glass insulation; polyethylene vapor-barrier film.
1. Pressure Rating: 8-inch wg (2280 Pa) positive or negative.
  2. Maximum Air Velocity: 5000 fpm (25 m/s).
  3. Temperature Range: Minus 20 to plus 250 deg F (Minus 29 to plus 121 deg C).
  4. Insulation R-Value: R4.2.



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2.4 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.
- B. Non-Clamp Connectors: Adhesive.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.
- C. Connect terminal units to supply ducts directly or with maximum 12-inch (300-mm) lengths of flexible duct. Do not use flexible ducts to change directions.
- D. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.
- E. Connect flexible ducts to metal ducts with adhesive.
- F. Install duct test holes where required for testing and balancing purposes.
- G. Installation:
  - 1. Install ducts fully extended.
  - 2. Do not bend ducts across sharp corners.
  - 3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
  - 4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
  - 5. Install flexible ducts in a direct line, without sags, twists, or turns.
- H. Supporting Flexible Ducts:
  - 1. Suspend flexible ducts with bands 1-1/2 inches (38 mm) wide or wider and spaced a maximum of 48 inches (1200 mm) apart. Maximum centerline sag between supports shall not exceed 1/2 inch (13 mm) per 12 inches (300 mm).
  - 2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
  - 3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.



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4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches (1800 mm) o.c.

**END OF SECTION 23 33 46**



## SECTION 233423 - HVAC POWER VENTILATORS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Centrifugal ventilators - roof upblast and sidewall.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
  - 2. Rated capacities, operating characteristics, and furnished specialties and accessories.
  - 3. Certified fan performance curves with system operating conditions indicated.
  - 4. Certified fan sound-power ratings.
  - 5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  - 6. Material thickness and finishes, including color charts.
  - 7. Dampers, including housings, linkages, and operators.
  - 8. Prefabricated roof curbs.
  - 9. Fan speed controllers.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
  - 4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints.



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- C. Delegated Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.
- B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.



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PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, supports, and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- F. Seismic Performance: HVAC power ventilators shall withstand the effects of earthquake motions determined according to ASCE/SEI 7See Section 230548 "Vibration and Seismic Controls for HVAC."
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Component Importance Factor: 1.0.
  - 3. .
- G. Wind Performance: Air-handling units shall withstand the effects of wind determined in accordance with to **ASCE/SEI 7**See Section 230548 "Vibration and Seismic Controls for HVAC."

2.2 CENTRIFUGAL VENTILATORS - ROOF UPBLAST OR SIDEWALL

- A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:
  - 1. [AirGenuity Inc.](#)
  - 2. [AirPro Fan Blower Co.](#)
  - 3. [Attic Breeze, LLC.](#)
  - 4. [Build Equinox.](#)
  - 5. [ClairiTech Innovations Inc.](#)



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6. [Cyclone Range Hoods Inc.](#)
7. [Envira-North Systems Ltd.](#)
8. [Fantech.](#)
9. [GAF Residential Roofing Products.](#)
10. [Jaga Canada Climate Systems Inc.](#)
11. [Keeptheheat LLC.](#)
12. [Lennox Industries, Inc.](#)
13. [Mestek.](#)
14. [Moffitt Corporation.](#)
15. [Napoleon Heating and Cooling.](#)
16. [Panasonic Life Solutions Company of America.](#)
17. [PennBarry.](#)
18. [QC Manufacturing, Inc.](#)
19. [S&P USA Ventilation Systems, LLC.](#)
20. [Schaefer Ventilation.](#)
21. [TEMP-AIR, Inc.](#)
22. [Tjernlund Products, Inc.](#)
23. [Walkair, LLC.](#)
24. [WindowMaster Control Systems Inc.](#)
25. [Zehnder America, Inc.](#)

B. Configuration: Centrifugal roof upblast ventilator.

C. Housing: Removable; square, one-piece aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
- 2.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Spark-resistant, all-aluminum wheel construction.
7. Mounting Pedestal: Galvanized steel with removable access panel.
8. Wall Mount Adapter: Attach wall-mounted fan to wall.
9. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust.



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- F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange  
Manufactured to accommodate roof slope.

## 2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

## 2.4 SOURCE QUALITY CONTROL

- A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.
- B. AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.
- C. AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.
- D. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Install power ventilators level and plumb.
- B. Equipment Mounting:
1. Secure roof-mounted fans to roof curbs with zinc-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.
  2. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
  3. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
  4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."



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- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

### 3.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

### 3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
  - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

### 3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

### 3.5 STARTUP SERVICE:

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
  - 2. Verify that shipping, blocking, and bracing are removed.
  - 3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.



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4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.
- D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

- A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections with the assistance of a factory-authorized service representative.



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1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.
3. Fans and components will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

**END OF SECTION 233423**



## **SECTION 233600 - AIR TERMINAL UNITS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

#### **1.2 SUMMARY**

**A. Section Includes:**

1. Modulating, single-duct air terminal units.

#### **1.3 INFORMATIONAL SUBMITTALS**

**A. Coordination Drawings:** Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.

**B. Seismic Qualification Data:** For air terminal units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

**C. Field quality-control reports.**

#### **1.4 CLOSEOUT SUBMITTALS**

**A. Operation and Maintenance Data:** For air terminal units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - a. Instructions for resetting minimum and maximum air volumes.



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- b. Instructions for adjusting software set points.
- c. Directons for resetting constant volume regulators.
- d. Parts list for each type of air terminal unit and troubleshooting maintenance guide.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fan-Powered-Unit Filters: Furnish one spare filter(s) for each filter installed.

1.6 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- E. Air terminal units shall be certified under AIR Standard 880-94 certification program and carry the ARI seal.
- F. Air terminal unit lining shall meet UL 181 and NFPA 90A standards.

PART 2 - PRODUCTS

2.1 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Anemostat Products; a Mestek company.
  - 2. ENVIRO-TEC; by Johnson Controls, Inc.
  - 3. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
  - 4. METALAIRE, Inc.
  - 5. Nailor Industries Inc.



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6. Price Industries.
  7. Titus, a division of Air System Components; Johnson Controls, Inc.
  8. Trane.
  9. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.
- B. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: Minimum 22-gauge- thick galvanized steel.
1. Casing Lining: 1" Eco-shield liner. Liner shall be ASTM C1071, C1338 G21 & G22.
  2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
  3. Air Outlet: S-slip and drive connections.
  4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
  2. Damper Position: Normally open.
  3. Terminal unit shall be pressure independent.
  4. The internal resistance of the terminal unit shall not exceed 0.5 inch w.g. when delivering maximum air volume (CFM).
- E. Velocity Sensors: Multipoint array with velocity inlet sensors.

## 2.2 SOURCE QUALITY CONTROL

- A. AHRI 880 Certification: Test, rate, and label assembled air terminal units in accordance with AHRI 880.
- B. Water Coils: Factory pressure test to 300 psig (2070 kPa) in accordance with AHRI 410 and ASHRAE 33.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 233113 "Metal Ducts" for hangers and supports.
- B. Install air terminal units according to NFPA 90A.



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- C. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- D. Coordinate access through ceilings with respective trades.
- E.

### 3.2 DUCTWORK CONNECTIONS

- A. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.
- B. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

### 3.3 ELECTRICAL CONNECTIONS

- A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

### 3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."



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3.5 IDENTIFICATION

- A. Label each air terminal unit with drawing designation, nominal airflow, maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
  - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
  - 3. Verify that controls and control enclosure are accessible.
  - 4. Verify that control connections are complete.
  - 5. Verify that nameplate and identification tag are visible.
  - 6. Verify that controls respond to inputs as specified.

3.7 ADJUSTING

- A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air terminal unit testing, adjusting, and balancing.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
  - 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.



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- D. Air terminal unit will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

**END OF SECTION 233600**



## **SECTION 23 37 13.13 - AIR DIFFUSERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Round ceiling diffusers.
  - 2. Rectangular and square ceiling diffusers.
  - 3. Perforated diffusers.
  - 4. Louver face diffusers.
  - 5. Linear slot diffusers.
  - 6. High-capacity drum louver diffusers.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  - 2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples: For each exposed product and for each color and texture specified. Actual size of smallest diffuser indicated.
- C. Samples for Initial Selection: For diffusers with factory-applied color finishes. Actual size of smallest diffuser indicated.
- D. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected. Actual size of smallest diffuser indicated.



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1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Ceiling suspension assembly members.
  - 2. Method of attaching hangers to building structure.
  - 3. Size and location of initial access modules for acoustical tile.
  - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
  - 5. Duct access panels.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 ROUND CEILING DIFFUSERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Anemostat Products; a Mestek company.
  - 2. Carnes Company.
  - 3. Hart & Cooley Inc.
  - 4. METALAIRE, Inc.
  - 5. Nailor Industries Inc.
  - 6. Price Industries.
  - 7. Shoemaker Mfg. Co.
  - 8. Titus, a division of Air System Components; Johnson Controls, Inc.
  - 9. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.
- C. Devices shall be specifically designed for variable-air-volume flows.
- D. Material:.
- E. Finish: Baked enamel, color selected by Architect.
- F. Face Style: Three cone.
- G. Mounting: Duct connection.
- H. Pattern: Fully adjustable.



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I. Dampers: Radial opposed blade.

J. Accessories:

1. Equalizing grid.
2. Plaster ring.
3. Safety chain.
4. Wire guard.
5. Sectorizing baffles.
6. Operating rod extension.

## 2.2 RECTANGULAR AND SQUARE CEILING DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. A-J Manufacturing Co., Inc.
2. Anemostat Products; a Mestek company.
3. Carnes Company.
4. Hart & Cooley Inc.
5. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
6. METALAIR, Inc.
7. Nailor Industries Inc.
8. Price Industries.
9. Shoemaker Mfg. Co.
10. Titus, a division of Air System Components; Johnson Controls, Inc.
11. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.

C. Devices shall be specifically designed for variable-air-volume flows.

D. Material: Steel.

E. Finish: Baked enamel, color selected by Architect.

F. Face Size:. See drawings

G. Face Style:4-way throw pattern .

H. Mounting: Surface T-bar.

I. Pattern: Adjustable.

J. Dampers: Radial opposed blade.

K. Accessories:



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1. Equalizing grid.
2. Plaster ring.
3. Safety chain.
4. Wire guard.
5. Sectorizing baffles.
6. Operating rod extension.

2.3 PERFORATED DIFFUSERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  1. A-J Manufacturing Co., Inc.
  2. Anemostat Products; a Mestek company.
  3. Carnes Company.
  4. Hart & Cooley Inc.
  5. Kees, Inc.
  6. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
  7. METALAIR, Inc.
  8. Nailor Industries Inc.
  9. Price Industries.
  10. Shoemaker Mfg. Co.
  11. Titus, a division of Air System Components; Johnson Controls, Inc.
  12. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.
  13. Warren Technology.
- C. Devices shall be specifically designed for variable-air-volume flows.
- D. Material: Steel backpan and pattern controllers, with steel face.
- E. Finish:.
- F. Face Size: See drawings.
- G. Duct Inlet: Round. Provide rectangular to round adaptor as required
- H. Face Style: Flush.
- I. Mounting: Surface T-bar.
- J. Pattern Controller: Four louvered deflector patches.
- K. Dampers: Radial opposed blade.
- L. Accessories:



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1. Equalizing grid.
2. Plaster ring.
3. Safety chain.
4. Wire guard.
5. Sectorizing baffles.
6. Operating rod extension.

2.4 LOUVER FACE DIFFUSERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  1. A-J Manufacturing Co., Inc.
  2. Anemostat Products; a Mestek company.
  3. Carnes Company.
  4. METALAIRE, Inc.
  5. Nailor Industries Inc.
  6. Price Industries.
  7. Shoemaker Mfg. Co.
  8. Titus, a division of Air System Components; Johnson Controls, Inc.
  9. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.
- C. Devices shall be specifically designed for variable-air-volume flows.
- D. Material: Steel.
- E. Finish: Baked enamel, color selected by Architect.
- F. Face Size: See drawings.
- G. Mounting: Surface T-bar.
- H. Pattern: Adjustable core style.
- I. Dampers: Radial opposed blade.
- J. Accessories:
  1. Square to round neck adaptor.
  2. Adjustable pattern vanes.
  3. Throw reducing vanes.
  4. Equalizing grid.
  5. Plaster ring.
  6. Safety chain.
  7. Wire guard.



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- 8. Sectorizing baffles.
- 9. Operating rod extension.

2.5 LINEAR SLOT DIFFUSERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Anemostat Products; a Mestek company.
  - 2. Carnes Company.
  - 3. Hart & Cooley Inc.
  - 4. Kees, Inc.
  - 5. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
  - 6. METALAIRE, Inc.
  - 7. Nailor Industries Inc.
  - 8. Price Industries.
  - 9. Raymon-Donco.
  - 10. Shoemaker Mfg. Co.
  - 11. Titus, a division of Air System Components; Johnson Controls, Inc.
  - 12. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.
- C. Devices shall be specifically designed for variable-air-volume flows.
- D. Material - Shell: Steel, insulated.
- E. Material - Pattern Controller and Tees: Aluminum.
- F. Finish - Face and Shell: Baked enamel, color selected by Architect.
- G. Finish - Pattern Controller: -Baked enamel, color selected by Architect.
- H. Finish - Tees: Baked enamel, color selected by Architect.
- I. Slot Width:. See drawings.
- J. Number of Slots:. See drawings.
- K. Length:. See drawings.
- L. Accessories: Plaster frame T-bar slot.
- M. Plenum box – Insulated with length to match linear. See drawings.



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2.6 HIGH-CAPACITY DRUM LOUVER DIFFUSERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Anemostat Products; a Mestek company.
  - 2. Carnes Company.
  - 3. Hart & Cooley Inc.
  - 4. Kees, Inc.
  - 5. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
  - 6. METALAIRE, Inc.
  - 7. Nailor Industries Inc.
  - 8. Price Industries.
  - 9. Titus, a division of Air System Components; Johnson Controls, Inc.
  - 10. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.
- C. Airflow Principle: Extended distance for high airflow rates.
- D. Material: Aluminum, heavy gage extruded.
- E. Finish: White baked acrylic.
- F. Border: 1-1/4-inch (32-mm) width with countersunk screw holes.
- G. Gasket between drum and border.
- H. Body: Drum shaped; adjustable vertically.
- I. Blades: Individually adjustable horizontally.
- J. Mounting: . See drawings
- K. Inlet Width:. See drawings
- L. Inlet Length:. See drawings
- M. Accessories:
  - 1. Opposed-blade steel damper.
  - 2. Duct-mounting collars with countersunk screw holes.

2.7 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."



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PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION 23 37 13.13**



## **SECTION 23 37 13.23 - REGISTERS AND GRILLES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Adjustable blade face registers and grilles.
  - 2. Fixed face registers and grilles.
  - 3. Linear bar grilles.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  - 2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples: For each exposed product and for each color and texture specified. Smallest size register and grille indicated.
- C. Samples for Initial Selection: For registers and grilles with factory-applied color finishes. Smallest size register and grille indicated.
- D. Samples for Verification: For registers and grilles, in manufacturer's standard sizes to verify color selected. Smallest size register and grille indicated.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:



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1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

- B. Source quality-control reports.

## PART 2 - PRODUCTS

### 2.1 REGISTERS

- A. Adjustable Blade Face Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. A-J Manufacturing Co., Inc.
  - b. Anemostat Products; a Mestek company.
  - c. Carnes Company.
  - d. Dayus Register & Grille Inc.
  - e. Hart & Cooley Inc.
  - f. Kees, Inc.
  - g. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
  - h. METALAIRE, Inc.
  - i. Nailor Industries Inc.
  - j. Price Industries.
  - k. Titus, a division of Air System Components; Johnson Controls, Inc.
  - l. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.
3. Material: Steel.
4. Finish: Baked enamel, color selected by Architect.
5. Face Blade Arrangement: Vertical spaced 3/4 inch (19 mm) apart.
6. Core Construction: Integral.
7. Frame: 1 inch (25 mm) wide.
8. Mounting: Concealed Lay in.
9. Damper Type: Adjustable opposed blade.
10. Accessories:
  - a. Front -blade gang operator.

- B. Fixed Face Register:



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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. A-J Manufacturing Co., Inc.
  - b. Anemostat Products; a Mestek company.
  - c. Carnes Company.
  - d. Dayus Register & Grille Inc.
  - e. Hart & Cooley Inc.
  - f. Kees, Inc.
  - g. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
  - h. Nailor Industries Inc.
  - i. Price Industries.
  - j. Shoemaker Mfg. Co.
  - k. Titus, a division of Air System Components; Johnson Controls, Inc.
  - l. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.
3. Material: Steel.
4. Finish: Baked enamel, color selected by Architect.
5. Face Blade Arrangement: Vertical spaced 3/4 inch (19 mm) apart.
6. Face Arrangement: Perforated core.
7. Core Construction: Integral.
8. Frame: 1 inch (25 mm) wide.
9. Mounting: Concealed Lay in.
10. Damper Type: Adjustable opposed blade.

## 2.2 GRILLES

### A. Adjustable Blade Face Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. A-J Manufacturing Co., Inc.
  - b. Anemostat Products; a Mestek company.
  - c. Carnes Company.
  - d. Dayus Register & Grille Inc.
  - e. Hart & Cooley Inc.
  - f. Kees, Inc.
  - g. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
  - h. METALAIRE, Inc.
  - i. Nailor Industries Inc.
  - j. Price Industries.
  - k. Raymon-Donco.



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- I. Shoemaker Mfg. Co.
    - m. Titus, a division of Air System Components; Johnson Controls, Inc.
    - n. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.
  - 3. Material: Steel.
  - 4. Finish: Baked enamel, color selected by Architect.
  - 5. Face Blade Arrangement: Vertical spaced 3/4 inch (19 mm) apart.
  - 6. Core Construction: Integral.
  - 7. Frame: 1 inch (25 mm) wide.
  - 8. Mounting: Concealed Lay in.
  - 9. Accessories:
    - a. Front -blade gang operator.
- B. Fixed Face Grille:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. A-J Manufacturing Co., Inc.
    - b. Anemostat Products; a Mestek company.
    - c. Carnes Company.
    - d. Dayus Register & Grille Inc.
    - e. Hart & Cooley Inc.
    - f. Kees, Inc.
    - g. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
    - h. Nailor Industries Inc.
    - i. Price Industries.
    - j. Shoemaker Mfg. Co.
    - k. Titus, a division of Air System Components; Johnson Controls, Inc.
    - l. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.
  - 3. Material: Steel.
  - 4. Finish: Baked enamel, color selected by Architect.
  - 5. Face Blade Arrangement: Vertical; spaced 3/4 inch (19 mm) apart.
  - 6. Face Arrangement: Perforated core.
  - 7. Core Construction: Integral.
  - 8. Frame: 1 inch (25 mm) wide.
  - 9. Mounting: Concealed Lay in.

## 2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."



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PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install registers and grilles level and plumb.
- B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION 23 37 13.23**



## **SECTION 23 72 19 - FIXED PLATE AIR-TO-AIR ENERGY RECOVERY UNITS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Fixed-plate sensible heat exchangers.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Sustainable Design Submittals:
  - 1. Product data showing compliance with ASHRAE 62.1.
- C. Shop Drawings: For air-to-air energy recovery equipment.
  - 1. Include plans, elevations, sections, and details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
- D. Delegated-Design Submittal: For air-to-air energy recovery equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Detail fabrication and assembly of air-to-air energy recovery equipment.



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1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
  - 2. Support location, type, and weight.
  - 3. Field measurements.
- B. Seismic Qualification Data: Certificates, for air-to-air energy recovery equipment, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in a clean, dry place.
- B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- C. Handle products carefully to prevent damage, breakage, denting, and scoring. Do not install damaged products.
- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.



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1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
3. Replace installed products damaged during construction.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.

1. .

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
- C. ASHRAE Compliance:
  1. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
  2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat/Energy Exchangers."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. Comply with ASTM E84.
- F. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to detail fabrication and assembly of air-to-air energy recovery equipment.
- G. Seismic Performance: Air-to-air energy recovery equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.



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1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: 1.0.
3. .

## 2.2 FIXED-PLATE SENSIBLE HEAT EXCHANGERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  1. [Airxchange, Inc.](#)
- B. Casing: Galvanized steel with duct collars.
- C. Plates: Evenly spaced, sealed, and arranged for cross airflow.
  1. Plate Material: Embossed aluminum.
  2. Plate Coating: Epoxy.
- D. Bypass Plenum: Within casing, with gasketed face-and-bypass dampers having operating rods extended outside casing.
- E. Maximum Differential Pressure: Suitable for maximum 6-inch wg (1500 Pa).
- F. Maximum Temperature: Suitable for maximum 194 deg F (90 deg C).

## 2.3 SOURCE QUALITY CONTROL

- A. AHRI 1060 Certification: Certified according to AHRI 1060.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical services to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.



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3.2 INSTALLATION

- A. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.
- B. Install floor-mounted units on 4-inch- (100-mm-) high, concrete base designed to withstand, without damage to equipment, seismic force required by code.
- C. Install seismic restraints according to manufacturers' written instructions.
- D. Install units with clearances for service and maintenance.
- E. Comply with requirements for ductwork specified in Section 23 31 13 "Metal Ducts."

3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 26 05 29 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 25 05 26 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
  - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.



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- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper water wash control and unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- E. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

### 3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Verify that shipping, blocking, and bracing are removed.
  - 3. Verify that unit is secure on mountings and supporting devices and that connections to electrical systems are complete. Verify that proper thermal-overload protection is installed.
  - 4. Verify water wash mechanism operation.
- B. Starting procedures for air-handling units include the following:
  - 1. Energize water wash motor and verify proper operation of motor and water wash system.
  - 2. Measure and record motor electrical values for voltage and amperage.

### 3.7 ADJUSTING

- A. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

### 3.8 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-to-air heat recovery unit, and after completing startup service, clean unit to remove foreign material and construction dirt and dust.



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3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fixed-plate air-to-air energy recovery units.

**END OF SECTION 23 72 19**



## **SECTION 23 74 16.13 - PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes packaged, large-capacity, rooftop air conditioning units (RTUs) with the following components:
  - 1. Casings.
  - 2. Fans, drives, and motors.
  - 3. Coils.
  - 4. Refrigerant circuit components.
  - 5. Air filtration.
  - 6. Dampers.
  - 7. Electrical power connections.
  - 8. Controls.
  - 9. Roof curbs.
  - 10. Accessories.

#### **1.3 DEFINITIONS**

- A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, large-capacity, rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each RTU.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
  - 3. Include unit dimensions and weight.
  - 4. Include cabinet material, metal thickness, finishes, insulation, and accessories.



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5. Fans:

- a. Include certified fan-performance curves with system operating conditions indicated.
  - b. Include certified fan-sound power ratings.
  - c. Include fan construction and accessories.
  - d. Include motor ratings, electrical characteristics, and motor accessories.
6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include gas furnaces with performance characteristics.
9. Include factory selection calculations for each antimicrobial ultraviolet lamp installation.
10. Include dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For air filtration performance.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Product Data: For energy performance.
5. Product Data: For refrigerants, indicating compliance with refrigerant management practices.

C. Shop Drawings: For each packaged, large-capacity, rooftop air-conditioning units.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Wind- and Seismic-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.



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1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Sample Warranty: For manufacturer's warranty.
- C. Seismic Qualification Data: Certificates, for RTUs, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  - 4. Restraint of internal components.
- D. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Source quality-control reports.
- F. System startup reports.
- G. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: 2 set(s) of filters for each unit.



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2. Gaskets: 2set(s) for each access door.

## 1.8 WARRANTY

- A. Warranty: Manufacturer agrees to repair or replace components of outdoor, semi-custom, air-handling unit that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: 2 year(s) from date of Substantial Completion.
  2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 Compliance: For refrigeration system safety.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. UL Compliance: Comply with UL 1995.
- G. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.
  1. Design RTU supports to comply with wind and seismic performance requirements.
- H. Wind-Restraint Performance:
  1. Basic Wind Speed: 110 MPH
  2. Building Classification Category: III
  3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.



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- I. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to ASCE 7
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified" and the unit will be fully operational after the seismic event.
  - 2. Component Importance Factor: 1.25.
  - 3. .

## 2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. AAON.
  - 2. Addison.
  - 3. Allied Commercial.
  - 4. Carrier Corporation.
  - 5. Daikin Applied.
  - 6. Engineered Air.
  - 7. Lennox Industries, Inc.; Lennox International.
  - 8. Trane.
  - 9. Valent.
  - 10. YORK; a Johnson Controls company.

## 2.3 UNIT CASINGS

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Double-Wall Construction:
  - 1. Outside Casing Wall: Galvanized steel, minimum 18 gauge (1.3 mm) thick with, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
  - 2. Inside Casing Wall: G90 (Z275)-coated galvanized steel, 0.028 inch (0.7 mm) thick, perforated 40 percent free area.
  - 3. Floor Plate: G90 (Z275) galvanized steel, treadplate, minimum 18 gauge (1.3 mm) thick.
  - 4. Casing Insulation:
    - a. Materials: Injected polyurethane foam insulation.
    - b. Insulation Thickness: 1 inch (25 mm).



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- c. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.
- C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- D. Panels and Doors:
  - 1. Panels:
    - a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
    - b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
    - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
    - d. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
  - 2. Access Doors:
    - a. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
    - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
    - c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
  - 3. Locations and Applications:
    - a. Fan Section:.
    - b. Access Section: Doors.
    - c. Coil Section: Inspection and access panels.
    - d. Damper Section: Inspection and access panels.
    - e. Filter Section: Inspection and access panels large enough to allow periodic removal and installation of filters.
    - f. Mixing Section: Doors.
- E. Condensate Drain Pans:
  - 1. Location: Each type of.
  - 2. Construction:
    - a. Single-wall, stainless steel sheet.
  - 3. Drain Connection:
    - a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.



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- b. Minimum Connection Size: NPS 3/4.
- 4. Slope: Minimum 0.125-in./ft. (10-mm/mm) slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
- 5. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
- 6. Width: Entire width of water producing device.
- 7. Depth: A minimum of 2 inches (50 mm) deep.
- 8. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
- 9. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

## 2.4 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.
  - 1. Shafts: With field-adjustable alignment.
    - a. Turned, ground, and polished hot-rolled steel with keyway.
  - 2. Shaft Bearings:
    - a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours according to ABMA 9.
  - 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
    - a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
  - 4. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.
  - 5. Mounting: For internal vibration isolation and seismic control. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 2 inch.
  - 6. Shaft Lubrication Lines: Extended to a location outside the casing.
- C. Drives, Direct: Factory-mounted, direct drive.



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- D. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated multispeed motors.
- E. Motors:
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  - 2. Enclosure Type: Totally enclosed, fan cooled.
  - 3. Enclosure Materials: Cast iron.
  - 4. Efficiency: Premium efficient as defined in NEMA MG 1.
  - 5. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

## 2.5 COILS

- A. General Requirements for Coils:
  - 1. Comply with AHRI 410.
  - 2. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
  - 3. Coils shall not act as structural component of unit.
- B. Supply-Air Refrigerant Coil:
  - 1. Tubes: Copper.
  - 2. Fins:
    - a. Material: Aluminum.
    - b. Fin Spacing: Maximum fins per inch (mm).
  - 3. Fin and Tube Joints: Mechanical bond.
  - 4. Headers: Seamless-copper headers with brazed connections.
  - 5. Frames:.
  - 6. Coatings: Corrosion-resistant coating.
  - 7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
    - a. Working Pressure: Minimum 300 psig (2070 kPa).

## 2.6 REFRIGERANT CIRCUIT COMPONENTS

- A. Number of Refrigerant Circuits: Two.
- B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- C. Refrigeration Specialties:



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1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.

## 2.7 AIR FILTRATION

### A. Panel Filters:

1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

- B. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.

## 2.8 DAMPERS

- A. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed -blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa) rated in accordance with AMCA 500D.)

- B. Barometric relief dampers.

### C. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."



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- b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
  - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
- 4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
  - 5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
  - 6. Size dampers for running torque calculated as follows:
    - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
    - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
    - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. (49.6 kg-cm/sq. m) of damper.
    - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
    - e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
    - f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
  - 7. Coupling: V-bolt and V-shaped, toothed cradle.
  - 8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
  - 9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
  - 10. Power Requirements (Two-Position Spring Return): 24 V dc.
  - 11. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
  - 12. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
  - 13. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).
  - 14. Run Time: 12 seconds open, 5 seconds closed.

## 2.9 ELECTRICAL POWER CONNECTIONS

- A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.



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2.10 CONTROLS

A. Basic Unit Controls:

1. Control-voltage transformer.
2. Wall-mounted thermostat or sensor with the following features:
  - a. Heat-cool-off switch.
  - b. Fan on-auto switch.
  - c. Fan-speed switch.
  - d. changeover.
  - e. Adjustable deadband.
  - f. Exposed set point.
  - g. Exposed indication.
  - h. Degree F indication.
  - i. Unoccupied-period-override push button.
  - j. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.

B. Electronic Controller:

1. Controller shall have volatile-memory backup.
2. Safety Control Operation:
  - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
  - b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F (54 deg C) enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
  - c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence
  - d. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
3. Scheduled Operation: Occupied and unoccupied periods on seven -day clock with a minimum of four programmable periods per day.
4. Unoccupied Period:
  - a. Heating Setback: Plus 10 deg F (Minus 11 deg C).
  - b. Cooling Setback: System off.
  - c. Override Operation: Two hours.
5. Supply Fan Operation:
  - a. Occupied Periods: Run fan continuously.
  - b. Unoccupied Periods: Cycle fan to maintain setback temperature.



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6. Refrigerant Circuit Operation:

- a. Occupied Periods: Cycle or stage compressors to match compressor output to cooling load to maintain room temperature. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
- b. Unoccupied Periods: Compressors off.
- c. Switch reversing valve for heating or cooling mode on air-to-air heat pump.

7. Economizer Outdoor-Air Damper Operation:

- a. Morning building outdoor air flush cycles.
- b. Occupied Periods: Open to 10 percent fixed minimum intake, and maximum 100 percent of the fan capacity. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F (15 deg C). Use outdoor-air temperature to adjust mixing dampers. During economizer cycle operation, lock out cooling.
- c. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
- d. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature, and output shall range from 2- to 10-V dc.

8. Carbon Dioxide Sensor Operation:

- a. Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 1000-ppm concentration.
- b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

C. Interface Requirements for HVAC Instrumentation and Control System:

- 1. Interface relay for scheduled operation.
- 2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.

2.11 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
- B. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 23 05 48 "Vibration and Seismic Controls for HVAC" for wind-load requirements.
- C. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.



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1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
    - a. Materials: ASTM C1071, Type I or II.
    - b. Thickness: 1 inch (25 mm).
  2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
    - a. Liner Adhesive: Comply with ASTM C916, Type I.
    - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
    - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
    - d. Liner Adhesive: Comply with ASTM C916, Type I.
- D. Curb Dimensions: Height of 14 inches (355 mm).

## 2.12 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.
- B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- C. Remote potentiometer to adjust minimum economizer damper position.
- D. Return-air bypass damper.
- E. Factory- or field-installed demand-controlled ventilation.
- F. Safeties:
  1. Smoke detector.
  2. Condensate overflow switch.
  3. Phase-loss reversal protection.
  4. High and low pressure control.
- G. Coil guards of painted, galvanized-steel wire.
- H. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.
- I. Door switches to disable heating or reset set point when open.



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- J. Outdoor air intake weather hood.
- K. Service Lights and Switch: Factory installed in fan and coil sections with weatherproof cover. Factory wire lights to a single-point field connection.

## 2.13 MATERIALS

- A. Steel:
  - 1. ASTM A36/A36M for carbon structural steel.
  - 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
  - 1. Manufacturer's standard grade for casing.
  - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209 (ASTM B209M).
- E. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000 -hour salt-spray test according to ASTM B117.
  - 1. Standards:
    - a. ASTM B117 for salt spray.
    - b. ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
    - c. ASTM B3359 for cross-hatch adhesion of 5B.
  - 2. Application: Spray.
  - 3. Thickness: 1 mil (0.025 mm).
  - 4. Gloss: Minimum gloss of 60 on a 60-degree meter.

## 2.14 SOURCE QUALITY CONTROL

- A. AHRI Compliance:
  - 1. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
  - 2. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs
  - 3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
  - 4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.
- B. AMCA Compliance:



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1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested in accordance with AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 07 72 00 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.
- B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
- C. Equipment Mounting:
  1. Comply with requirements for vibration isolation and seismic control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
  2. Comply with requirements for vibration isolation devices specified in Section 23 05 48.13 "Vibration Controls for HVAC."

### 3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to RTU, allow space for service and maintenance.



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- C. Connect piping to unit mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using NPS 1-1/4 (DN 32), ASTM B88, Type M (ASTM B88M, Type C) copper tubing. Extend to nearest equipment or roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E. Refrigerant Piping: Comply with applicable requirements in Section 23 23 00 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

### 3.4 DUCT CONNECTIONS

- A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  - 1. Install ducts to termination at top of roof curb.
  - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
  - 3. Install return-air duct continuously through roof structure.

### 3.5 ELECTRICAL CONNECTIONS

- A. Connect electrical wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs as specified in Section 26 05 53 "Identification for Electrical Systems."
  - 2. Nameplate shall be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least 1/2 inch (13 mm) high.
  - 3. Locate nameplate where easily visible.

### 3.6 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.



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- B. Connect control wiring according to Section 26 05 23 "Control-Voltage Electrical Power Cables."

### 3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions.
  - 1. Inspect for visible damage to unit casing.
  - 2. Inspect for visible damage to furnace combustion chamber.
  - 3. Inspect for visible damage to compressor, coils, and fans.
  - 4. Inspect internal insulation.
  - 5. Verify that labels are clearly visible.
  - 6. Verify that clearances have been provided for servicing.
  - 7. Verify that controls are connected and operable.
  - 8. Verify that filters are installed.
  - 9. Clean condenser coil and inspect for construction debris.
  - 10. Remove packing from vibration isolators.
  - 11. Inspect operation of barometric relief dampers.
  - 12. Verify lubrication on fan and motor bearings.
  - 13. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  - 14. Start unit according to manufacturer's written instructions.
    - a. Start refrigeration system.
    - b. Do not operate below recommended low-ambient temperature.
    - c. Complete startup sheets and attach copy with Contractor's startup report.
  - 15. Inspect and record performance of interlocks and protective devices; verify sequences.
  - 16. Operate unit for an initial period as recommended or required by manufacturer.
  - 17. Calibrate thermostats.
  - 18. Adjust and inspect high-temperature limits.
  - 19. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
  - 20. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F (8 deg C) above return-air temperature:
    - a. Coil leaving-air, dry- and wet-bulb temperatures.
    - b. Coil entering-air, dry- and wet-bulb temperatures.
    - c. Outdoor-air, dry-bulb temperature.
    - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
  - 21. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.



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22. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
  - a. Supply-air volume.
  - b. Return-air volume.
  - c. Relief-air volume.
  - d. Outdoor-air intake volume.
23. Simulate maximum cooling demand and inspect the following:
  - a. Compressor refrigerant suction and hot-gas pressures.
  - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
24. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
  - a. High-temperature limit on gas-fired heat exchanger.
  - b. Low-temperature safety operation.
  - c. Filter high-pressure differential alarm.
  - d. Economizer to minimum outdoor-air changeover.
  - e. Relief-air fan operation.
  - f. Smoke and firestat alarms.
25. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

### 3.8 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.
- C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.9 CLEANING

- A. After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems and after completing startup service, clean RTUs internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.



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3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
  - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. RTU will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

**END OF SECTION 23 74 16.13**



## **SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Sustainable Design Submittals:
  - 1. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
  - 2. Product Data: For energy performance.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
- D. Samples for Initial Selection: For units with factory-applied color finishes.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.



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1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: One set(s) for each air-handling unit.
  - 2. Gaskets: One set(s) for each access door.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
  - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
  - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period:



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- a. For Compressor: Five year(s) from date of Substantial Completion.
- b. For Parts: Five year(s) from date of Substantial Completion.
- c. For Labor: Five year(s) from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:

- 1. [Allied Commercial.](#)
- 2. [Ameristar Heating and Cooling.](#)
- 3. [Danby Products Inc.](#)
- 4. [Data Aire Inc.](#)
- 5. [Lennox Industries, Inc.](#)
- 6. [Marvair.](#)
- 7. [MRCOOL.](#)
- 8. [Napoleon Heating and Cooling.](#)
- 9. [Panasonic Heating and Air Conditioning Solutions.](#)
- 10. [Samsung HVAC.](#)
- 11. [TOSOT Comfort.](#)

### 2.2 INDOOR UNITS (5 TONS (18 KW) OR LESS)

- A. Wall-Mounted, Evaporator-Fan Components:

- 1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
- 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
- 3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
- 4. Fan: Direct drive, centrifugal.
- 5. Fan Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
  - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
  - c. Enclosure Type: Totally enclosed, fan cooled.



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- d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
  - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
  - f. Mount unit-mounted disconnect switches on exterior of unit.
  - g. .
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Condensate Drain Pans:
- a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
    - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
    - 2) Depth: A minimum of 1 inch (25 mm) deep.
  - b. Single-wall, galvanized -steel sheet.
  - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
    - 1) Minimum Connection Size: NPS 1 (DN 25).
  - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
8. Air Filtration Section:
- a. General Requirements for Air Filtration Section:
    - 1) Comply with NFPA 90A.
    - 2) Minimum MERV according to ASHRAE 52.2.
    - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

## 2.3 OUTDOOR UNITS (5 TONS (18 KW) OR LESS)

### A. Air-Cooled, Compressor-Condenser Components:

- 1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.



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- a. Compressor Type: Scroll.
  - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
  - c. Refrigerant: R-410A.
  - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
  4. Fan: Aluminum-propeller type, directly connected to motor.
  5. Motor: Permanently lubricated, with integral thermal-overload protection.
  6. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
  7. Mounting Base: Polyethylene.

## 2.4 ACCESSORIES

- A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
  1. Compressor time delay.
  2. 24-hour time control of system stop and start.
  3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
  4. Fan-speed selection including auto setting.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- E. Drain Hose: For condensate.
- F. Monitoring:
  1. Monitor constant and variable motor loads.
  2. Monitor variable-frequency-drive operation.
  3. Monitor economizer cycle.
  4. Monitor cooling load.
  5. Monitor air distribution static pressure and ventilation air volumes.



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PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 07 72 00 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting:
  - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
  - 2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
  - 3. Comply with requirements for vibration isolation and seismic control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
  - 4. Comply with requirements for vibration isolation devices specified in Section 23 05 48.13 "Vibration Controls for HVAC."
- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:



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1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

### 3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. .

### 3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

**END OF SECTION 23 81 26**



## **SECTION 23 81 29 - VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes: VRF HVAC systems.
  - 1. Indoor, concealed, ceiling-mounted units for ducting.
  - 2. Outdoor, air-source heat recovery units.
  - 3. Heat recovery control units (HRCUs).
  - 4. System controls.
  - 5. System refrigerant and oil.
  - 6. System condensate drain piping.
  - 7. System refrigerant piping.
  - 8. Outdoor equipment stands.
  - 9. Miscellaneous support materials.
  - 10. Piping and tubing insulation.
  - 11. System control cable.

#### **1.2 DEFINITIONS**

- A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.
- B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.
- C. Heat Recovery System Operation: System capable of operation with simultaneous heating and cooling zones that transfer heat between zones.
- D. HRCU: Heat Recovery Control Unit. HRCUs are used in heat recovery VRF HVAC systems to manage and control refrigerant between indoor units to provide simultaneous heating and cooling zones. "Heat Recovery Control Unit" is the term used by ASHRAE for what different manufacturers term as branch circuit controller, branch selector box, changeover box, flow selector unit, mode change unit, and other such terms.
- E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- F. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.



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- G. Three-Pipe System Design: One high pressure refrigerant vapor line, one low pressure refrigerant vapor line, and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One liquid line and refrigerant vapor line connect HRCUs to associated indoor units.
- H. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high and low pressure refrigerant between indoor units.
- I. VRF: Variable refrigerant flow.

### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For VRF HVAC system components.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for HRCUs.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
  - 4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
  - 5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and HRCU control.
  - 6. Include description of control software features.
  - 7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
  - 8. Include refrigerant type and data sheets showing compliance with requirements indicated.
  - 9. For system design software.
  - 10. Indicate location and type of service access.
- B. Sustainable Design Submittals:
  - 1. Product Data: For minimum energy performance.
  - 2. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
  - 3. ASHRAE/IES 90.1 compliance.



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4. Air-Balance Report: Documentation indicating that Work complies with ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
  5. HVAC Flush Report: Documentation indicating that building HVAC system flush complies with Green Globes v1.4, Section 3.2.4.4 - "IAQ during Construction."
  6. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
  7. Product Data for EA Credit "Optimize Energy Performance": Indicating that system meets efficiency requirements.
  8. Product Data for EA Credit "Enhanced Refrigerant Management": Indicating that products meet requirements for refrigerant management.
  9. Product Data: For continuous metering equipment for energy consumption.
  10. Product Data for EQ Credit "Acoustic Performance": Documentation indicating that systems and equipment comply.
  11. Thermal Comfort: Product Data indicating that systems, equipment, and controls comply.
  12. .
- C. Shop Drawings: For VRF HVAC systems.
1. Include plans, elevations, sections, and attachment details.
  2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
  4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
  5. Include diagrams for power, signal, and control wiring.
- D. Samples for Initial Selection: For fully and partially exposed indoor units with factory finishes viewable by occupants.
1. Include a Sample for each unique finish with unit identification, detailed description of application, and cross-referenced floor plans showing locations.
- E. Delegated Design Submittals:
1. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  2. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.
  3. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.
  4. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.
  5. .



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1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural floors, roofs and associated members to which equipment, piping, ductwork, cables, and conduit will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
5. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.
6. Items penetrating finished ceiling including the following:
  - a. Luminaires.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Service access panels.
  - f. .

- B. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
  - a. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation
  - b. Installer certification shall be valid and current for duration of Project
  - c. Retain copies of Installer certificates on-site and make available on request
  - d. Each person assigned to Project shall have demonstrated past experience
    - 1) Demonstrated past experience with products being installed for period within five consecutive years before time of bid
    - 2) Demonstrated past experience on five projects of similar complexity, scope, and value
2. For VRF HVAC system manufacturer.
  - a. Nationally recognized manufacturer of VRV HVAC systems and products
  - b. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of 10 years within time of bid



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- c. VRF HVAC systems and products that have been successfully tested and in use on at least five completed projects
  - d. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use
  - e. Having full-time in-house employees for the following:
    - 1) Product research and development
    - 2) Product and application engineering
    - 3) Product manufacturing, testing, and quality control
    - 4) Technical support for system installation training, startup, commissioning, and troubleshooting of installations
    - 5) Owner training
3. For VRF HVAC factory-authorized service representative.
- a. Authorized representative of, and trained by, VRV HVAC system manufacturer
  - b. In-place facility located within 50 miles of Project
  - c. Demonstrated past experience with products being installed for period within five consecutive years before time of bid
  - d. Demonstrated past experience on five projects of similar complexity, scope, and value
    - 1) Each person assigned to Project shall have demonstrated past experience
  - e. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule
  - f. Service and maintenance staff assigned to support Project during warranty period
  - g. Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion
  - h. VRV HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested
  - i. Manufacturer Service Group to visit site at least three times during project execution PRIOR TO SYSTEM STARTUP:
    - 1) First site visit for pre-construction coordination meeting
    - 2) Second site visit during construction once installation has commenced but before piping installation is completed for piping layout review
    - 3) Third site visit for pre-startup tasks overview once system is installed but not started
- C. Seismic Qualification Data: Certificates, for equipment, accessories, and components, from manufacturer.
- 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.



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3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For VRF HVAC system components.

1. .

E. Product Test Reports: Where tests are required, for each product, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranties: For manufacturer's warranties.

#### 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters:

- a. 2 set(s) for each unit with replaceable filters.
- b. 2 set(s) for each unit type and unique size of washable filters.

2. Indoor Units: One for each unique size and type installed.

3. Controllers for Indoor Units: One for each unique controller type installed.

4. .

#### 1.8 QUALITY ASSURANCE

A. Mockups: Build mockups to set quality standards for materials and execution.



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1. Build mockups to show a finished installation for each of the following applications:
    - a. For each different indoor unit type with exposed surfaces viewable by occupants.
    - b. .
  2. Mockups shall be operational.
  3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- B. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in a clean and dry place.
- B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.
- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
  1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
  2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
- E. Replace installed products damaged during construction.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Structural failures.



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- b. Faulty operation.
  - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
  - d. .
2. Warranty Period:
- a. For Compressor: 10 year(s) from date of Substantial Completion.
  - b. For Parts, Including Controls: year(s) from date of Substantial Completion.
  - c. For Labor: Five year(s) from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 VRF HVAC SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following]:

- 1. [Ace Coil Manufacturing.](#)
- 2. [AirGenuity Inc.](#)
- 3. [Applied Air, a Mestek company.](#)
- 4. [Arrco, LLC.](#)
- 5. [Arzel Zoning Technology, Inc.](#)
- 6. [Carrier Corp.](#)
- 7. [ComfortStar.](#)
- 8. [Custom Mechanical Equipment.](#)
- 9. [Daikin North America LLC.](#)
- 10. [Fujitsu General America, Inc.](#)
- 11. [Kwikool Portable Cooling Systems.](#)
- 12. [LG Air Conditioning Technologies USA.](#)
- 13. [Mitsubishi Electric & Electronics USA Inc. / HVAC Advanced Products Division.](#)
- 14. [Napoleon Heating and Cooling.](#)
- 15. [Panasonic Heating and Air Conditioning Solutions.](#)
- 16. [PRO Hydronic Specialties.](#)
- 17. [Quality Flow Controls.](#)
- 18. [Samsung HVAC.](#)
- 19. [Thermolec Ltd.](#)
- 20. [Trane.](#)
- 21. [Walkair, LLC.](#)

- B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

- 1. Indoor and outdoor units, including accessories.
- 2. Controls and software.



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3. HRCUs.
4. Refrigerant isolation valves.
5. Specialty refrigerant pipe fittings.
6. Insert products.

## 2.2 SYSTEM DESCRIPTION

- A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.
  1. three-pipe system design.
  2. System(s) operation, heat recovery as indicated on Drawings.
  3. Each system with one refrigerant circuit shared by all indoor units connected to system.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.
- D. ASHRAE Compliance:
  1. ASHRAE 15: For safety code for mechanical refrigeration.
  2. ASHRAE 62.1: For indoor air quality.
  3. ASHRAE 135: For control network protocol with remote communication.
  4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.
- E. UL Compliance: Comply with UL 1995.

## 2.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional specialist, as defined in Section 01 40 00 "Quality Requirements," to design complete and operational VRF HVAC system(s) complying with requirements indicated.
  1. Provide system refrigerant calculations.
    - a. Refrigerant concentration limits shall be within allowable limits of ASHRAE 15 and governing codes.
    - b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.



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2. Include a mechanical ventilation system and gas detection system as required to comply with ASHRAE 15 and governing codes.
  3. System Refrigerant Piping and Tubing:
    - a. Arrangement: Arrange piping to interconnect indoor units, HRCUs, and outdoor unit(s) in compliance with manufacturer requirements and requirements indicated.
    - b. Routing: Conceal piping above ceilings and behind walls to maximum extent possible.
    - c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated. Consider requirements to accommodate future change requirements.
  4. System Controls:
    - a. Network arrangement.
    - b. Network interface with other building systems.
    - c. Product selection.
    - d. Sizing.
- B. Service Access:
1. Provide and document service access requirements.
  2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
  3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
  4. If less than full and unrestricted access is provided, locate components within an 18-inch (450-mm) reach of the finished assembly.
  5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
  6. Comply with OSHA regulations.
- C. System Design and Installation Requirements:
1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
  2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.
- D. Isolation of Equipment: Provide isolation valves to isolate each HRCU, indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.



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- E. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:
1. Not less than 50 percent.
  2. Not more than 130 percent.
  3. Range acceptable to manufacturer.
- F. System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.
- G. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.
- H. Outdoor Conditions:
1. Suitable for outdoor ambient conditions encountered.
    - a. Design equipment and supports to withstand wind loads of governing code and ASCE/SEI 7.
    - b. Design equipment and supports to withstand snow and ice loads of governing code and ASCE/SEI 7.
    - c. Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.
  2. Maximum System Operating Outdoor Temperature: See Drawings.
  3. Minimum System Operating Outdoor Temperature: See Drawings.
- I. Seismic Performance: VRF HVAC system(s) shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
  2. Component Importance Factor: 1.0.
  3. Insert requirements for Component Amplification Factor and Component Response Modification Factor.
- J. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.
1. Indoor: Within design guidelines of "2015 ASHRAE HANDBOOK- HVAC Applications."
  2. Outdoor: Within ordinance of governing authorities.
- K. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.
- L. Capacities and Characteristics: As indicated on Drawings.



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2.4 INDOOR, CONCEALED, CEILING-MOUNTED UNITS FOR DUCTING

- A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
- B. Cabinet:
  - 1. Material: Galvanized steel.
  - 2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
  - 3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
  - 4. Mounting: Manufacturer-designed provisions for field installation.
  - 5. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
- C. DX Coil Assembly:
  - 1. Coil Casing: Aluminum, galvanized, or stainless steel.
  - 2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
  - 3. Coil Tubes: Copper, of diameter and thickness required by performance.
  - 4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
  - 5. Unit Internal Tubing: Copper tubing with brazed joints.
  - 6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
  - 7. Field Piping Connections: Manufacturer's standard.
  - 8. Factory Charge: Dehydrated air or nitrogen.
  - 9. Testing: Factory pressure tested and verified to be without leaks.
- D. Drain Assembly:
  - 1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
  - 2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
  - 3. Field Piping Connection: Non-ferrous material.
- E. Fan and Motor Assembly:
  - 1. Fan(s):
    - a. Direct-drive arrangement.
    - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
    - c. Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.



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- d. Wheels statically and dynamically balanced.
  - 2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
  - 3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
  - 4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
  - 5. Vibration Control: Integral isolation to dampen vibration transmission.
- F. Filter Assembly:
- 1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
  - 2. Efficiency: ASHRAE 52.2, MERV 13.
  - 3. Media:
    - a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
- G. Unit Accessories:
- 1. Outdoor Air Ventilation Kit: Connection, motorized damper, and control sized to allow sequence of operation indicated on Drawings.
  - 2. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
  - 3. Insert accessories.
- H. Unit Controls:
- 1. Enclosure: Metal, suitable for indoor locations.
  - 2. Factory-Installed Controller: Configurable digital control.
  - 3. Factory-Installed Sensors:
    - a. Unit inlet air temperature.
    - b. Coil entering refrigerant temperature.
    - c. Coil leaving refrigerant temperature.
    - d. .
  - 4. Field-Customizable I/O Capability:
    - a. Analog Inputs: Four for use in customizable control strategies.
    - b. Digital Inputs: Four for use in customizable control strategies.
    - c. Digital Outputs: Four for use in customizable control strategies.
  - 5. Features and Functions:



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- a. Self-diagnostics.
  - b. Time delay.
  - c. Auto-restart.
  - d. External static pressure control.
  - e. Auto operation mode.
  - f. Manual operation mode.
  - g. Filter service notification.
  - h. Power consumption display.
  - i. Drain assembly high water level safety shutdown and notification.
  - j. Run test switch.
  - k. .
- 6. Communication: Network communication with other indoor and outdoor units.
  - 7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
  - 8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
- I. Unit Electrical:
- 1. Enclosure: Metal, suitable for indoor locations.
  - 2. Field Connection: Single point connection to power unit and integral controls.
  - 3. Disconnecting Means: Factory-mounted circuit breaker or switch.
  - 4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
  - 5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
  - 6. Raceways: Enclose line voltage wiring in [**metal**] raceways.

## 2.5 OUTDOOR, AIR-SOURCE HEAT RECOVERY UNITS

- A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
- 1. Specially designed for use in systems with simultaneous heating and cooling.
  - 2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
  - 3. All units installed shall be from the same product development generation.
- B. Cabinet:
- 1. Galvanized steel and coated with a corrosion-resistant finish.
    - a. Coating with documented salt spray test performance of 1000 hours according ASTM B117 surface scratch test (SST) procedure.



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2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:
  - a. High refrigerant pressure.
  - b. Low oil level.
  - c. High oil temperature.
  - d. Thermal and overload.
  - e. Voltage fluctuations.
  - f. Phase failure and phase reversal.
  - g. Short cycling.
  - h. .
3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

D. Condenser Coil Assembly:

1. Plate Fin Coils:
  - a. Casing: Aluminum, galvanized, or stainless steel.
  - b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
  - c. Tubes: Copper, of diameter and thickness required by performance.
2. Aluminum Microchannel Coils:
  - a. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
  - b. Single- or multiple-pass arrangement.
  - c. Construct fins, tubes, and header manifolds of aluminum alloy.
3. Coating: Corrosion resistant.
4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.



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E. Condenser Fan and Motor Assembly:

1. Fan(s): Propeller type.
  - a. Direct-drive arrangement.
  - b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
  - c. Statically and dynamically balanced.
2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.
6. Vibration Control: Integral isolation to dampen vibration transmission.

F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

G. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:
  - a. Refrigerant suction temperature.
  - b. Refrigerant discharge temperature.
  - c. Outdoor air temperature.
  - d. Refrigerant high pressure.
  - e. Refrigerant low pressure.
  - f. Oil level.
  - g. Insert sensor.
4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode , night setback control , power consumption display equalize run time between multiple same components.
5. Communication: Network communication with indoor units and other outdoor unit(s).
6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.



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H. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevent corrosion when exposed to salt spray test for 1000 hours according ASTM B117.

J. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.6 HEAT RECOVERY CONTROL UNITS (HRCUS)

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.

B. Cabinet:

1. Galvanized-steel construction.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.



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- C. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
- D. Refrigeration Assemblies and Specialties:
1. Specially designed by manufacturer for type of VRF HVAC system being installed, either two or three pipe.
  2. Each refrigerant branch circuit shall have refrigerant control valve(s) to control refrigerant flow.
  3. Spares: Each heat recovery control unit shall include at least one branch circuit port(s) for future use.
  4. Each system piping connection upstream of heat recovery unit shall be fitted with an isolation valve to allow for service to any heat recovery control unit in the system without interrupting operation of the system.
  5. Each branch circuit connection shall be fitted with an isolation valve and capped service port to allow for service to any individual branch circuit without interrupting operation of the system.
    - a. If not available as an integral part of the heat recovery control unit, isolation valves shall be field installed adjacent to the unit pipe connection.
- E. Unit Controls:
1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
  2. Factory-Installed Controller: Configurable digital control.
  3. Features and Functions: Self-diagnostics, fuse protection,.
  4. Communication: Network communication with indoor units and outdoor unit(s).
  5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
  6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
- F. Unit Electrical:
1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
  2. Field Connection: Single point connection to power entire unit and integral controls.
  3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
  4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
  5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
  6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.
- G. Unit Piping:
1. Unit Tubing: Copper tubing with brazed joints.



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2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

## 2.7 SYSTEM CONTROLS

### A. General Requirements:

1. Network: Indoor units, HRCUs, and outdoor units shall include integral controls and connect through a manufacturer-selected control network.
2. Network Communication Protocol: open control communication between interconnected units.
3. Operator Interface:
  - a. Operators shall interface with system and unit controls through the following:
    - 1) Operator interfaces integral to controllers.
    - 2) Owner-furnished PC connected to central controller(s).
    - 3) Web interface through web browser software.
    - 4) Cloud-based accessibility (Turntide)
  - b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:
    - 1) On/off control.
    - 2) Temperature set-point adjustment.
    - 3) .

### B. VRF HVAC System Operator Software for PC:

1. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.
2. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.



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5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
7. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
8. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
9. Supports Multiple Languages: English.
10. Supports Imperial and Metric Temperature Units: Fahrenheit.
11. Displays service notifications and error codes.
12. Monitors and displays up to 3000 item error history and 10000 item operation history for regular reporting and further archiving.
13. Monitors and displays cumulative operating time of indoor units.
14. Able to disable and enable operation of individual controllers for indoor units.
15. Information displayed on individual controllers shall also be available for display.
16. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.

C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.
  - a. Include multiple interconnected controllers as required.
2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
  - a. Sets schedule for daily, weekly, and annual events.
  - b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.
4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Service diagnostics tool.
8. Able to disable and enable operation of individual controllers for indoor units.
9. Information displayed on individual controllers shall also be available for display through central controller.



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10. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.
11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
12. Operator interface through a backlit, high-resolution color display touch panel and web accessible through standard web browser software.

D. Wired Controllers for Indoor Units:

1. Single controller capable of controlling multiple indoor units as group.
2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
3. Multiple Language: English.
4. Temperature Units: Fahrenheit.
5. On/Off: Turns indoor unit on or off.
6. Hold: Hold operation settings until hold is released.
7. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
8. Temperature Display: 1-degree increments.
9. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments .
10. Relative Humidity Display: 1 percent increments.
11. Relative Humidity Set-Point: Adjustable in 1 percent increments.
12. Fan Speed Setting: Select between available options furnished with the unit.
13. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
14. Seven-day programmable operating schedule with up to eight events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
15. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
16. Occupancy detection.
17. Service Notification Display: "Filter".
18. Service Run Tests: Limit use by service personnel to troubleshoot operation.
19. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
20. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
21. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.
22. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.
23. .

## 2.8 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
2. ASHRAE 34, Class A1 refrigerant classification.



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3. R-410a.

B. Oil:

1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

## 2.9 SYSTEM CONDENSATE DRAIN PIPING

A. If more than one material is listed, material selection is Contractor's option.

B. Copper Tubing:

1. Drawn-Temper Tubing: According to ASTM B88, Type L (ASTM B88M, Type B) or Type DWV according to ASTM B306.
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B32, lead-free alloys, and water-flushable flux according to ASTM B813.

C. CPVC plastic pipe according to ASTM F441/F441M, Schedule 40, with socket-type pipe fittings according to ASTM F438 and solvent cement according to ASTM F493.

D. PVC plastic pipe according to ASTM D1785, Schedule 40, with socket-type pipe fittings according to ASTM D2466 and solvent cement according to ASTM D2564, primer according to ASTM F656.

## 2.10 SYSTEM REFRIGERANT PIPING

A. Comply with requirements in Section 23 23 00 "Refrigerant Piping" for system piping requirements.

B. Refrigerant Piping:

1. Copper Tube: ASTM B280, Type ACR.
2. Wrought-Copper Fittings: ASME B16.22.
3. Brazing Filler Metals: AWS A5.8/A5.8M.

C. Refrigerant Tubing Kits:

1. Furnished by VRF HVAC system manufacturer.
2. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.
3. Standard one-piece length for connecting to indoor units.
4. Pre-insulated with flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.
5. Factory Charge: Dehydrated air or nitrogen.



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- D. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.
- E. Refrigerant Isolation Ball Valves:
  - 1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
  - 2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.
  - 3. Valve Connections: Flare or sweat depending on size.

## 2.11 MISCELLANEOUS SUPPORT MATERIALS

- A. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- B. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.
- C. Threaded Rods: Continuously threaded. Zinc-plated steel or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar material as rods.

## 2.12 PIPING AND TUBING INSULATION

- A. Condensate Drain Piping and Tubing Insulation and Jacket Requirements:
  - 1. Flexible Elastomeric Insulation:
    - a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
    - b. Indoors: 3/4 inch (19 mm) thick.
    - c. Outdoors: 3/4 inch (19 mm) thick.
  - 2. Field-Applied Jacket:
    - a. Concealed: None required.
    - b. Indoors, Exposed to View: PVC, 20 mils (0.5 mm) thick.
    - c. Outdoors, Exposed to View: Aluminum, smooth, 0.020 inch (0.51 mm) thick.
- B. Refrigerant Tubing Insulation and Jacket Requirements:



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1. Flexible Elastomeric Insulation:
    - a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
    - b. Indoors: 1 inch (25 mm) thick.
    - c. Outdoors: 1 inch (25 mm) thick.
  2. Field-Applied Jacket:
    - a. Concealed: None required.
    - b. Indoors, Exposed to View: PVC, 20 mils (0.5 mm) thick.
    - c. Outdoors, Exposed to View: Aluminum, smooth, 0.020 inch (0.51 mm) thick.
- C. Flexible Elastomeric Insulation Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.
- E. Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
  2. Fire- and water-resistant, flexible, elastomeric sealant.
  3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
  4. Color: Aluminum.
  5. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and acetaldehyde concentration does not exceed 9 mcg/cu. m.



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2.13 SYSTEM CONTROL CABLE

A. Cable Rating: Listed and labeled for application according to NFPA 70.

1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
  - a. Flame Travel Distance: 60 inches (1520 mm) or less.
  - b. Peak Optical Smoke Density: 0.5 or less.
  - c. Average Optical Smoke Density: 0.15 or less.
2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
3. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

B. Low-Voltage Control Cabling:

1. Paired Cable: NFPA 70, Type CMG.
  - a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
  - b. PVC insulation.
  - c. Braided or foil shielded.
  - d. PVC jacket.
  - e. Flame Resistance: Comply with UL 1685.
2. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
  - a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
  - b. PVC insulation.
  - c. Braided or foil shielded.
  - d. PVC jacket.
  - e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.
  - f. Flame Resistance: Comply with NFPA 262.
3. Lead Content: Less than 300 parts per million.

C. TIA-485A Network Cabling:

1. Standard Cable: NFPA 70, Type CMG.
  - a. Paired,, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.



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- b. PVC insulation.
    - c. Unshielded.
    - d. PVC jacket.
    - e. Flame Resistance: Comply with UL 1685.
  - 2. Plenum-Rated Cable: NFPA 70, Type CMP.
    - a. Paired,, No. 22 AWG, stranded (7x30) tinned-copper conductors.
    - b. Fluorinated ethylene propylene insulation.
    - c. Unshielded.
    - d. Fluorinated ethylene propylene jacket.
    - e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.
    - f. Flame Resistance: NFPA 262.
  - 3. Lead Content: Less than 300 parts per million.
- D. Ethernet Network Cabling: TIA-568-C.2 Category 6 cable with RJ-45 connectors.
- 1. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of category cable indicated.
  - 2. Conductors: 100-ohm, 23 AWG solid copper.
  - 3. Lead Content: Less than 300 parts per million.
  - 4. Shielding: Shielded twisted pairs (FTP).
  - 5. Cable Rating: By application.
  - 6. Jacket: White thermoplastic.
- E. Comply with requirements in Section 26 05 33.13 "Conduits for Electrical Systems" for cable raceways.

## 2.14 MATERIALS

- A. Steel:
  - 1. ASTM A36/A36M for carbon structural steel.
  - 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
  - 1. Manufacturer's standard grade for casing.
  - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209.



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- E. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000 -hour salt-spray test according to ASTM B117.

1. Standards:

- a. ASTM B117 for salt spray.
- b. ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
- c. ASTM B3359 for cross-hatch adhesion of 5B.

2. Application: Spray.

3. Thickness: 1 mil (0.025 mm).

4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.15 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect factory-assembled equipment.
- B. Equipment will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.
- D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.
- E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.
- F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.



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- G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 EQUIPMENT INSTALLATION, GENERAL

- A. Clearance:
  - 1. Maintain manufacturer's recommended clearances for service and maintenance.
  - 2. Maintain clearances required by governing code.
- B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.
  - 1. Loose components shall be installed by system Installer under supervision of manufacturer's service representative.
- C. Equipment Restraint Installation: Install equipment with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

### 3.3 INSTALLATION OF INDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.
- B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch (10 mm).
- C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.
- D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.
- E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.
- F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.
- G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch (13 mm).
- H. For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.



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- I. Attachment: Install hardware for proper attachment to supported equipment.
- J. Grouting: Place grout under equipment supports and make bearing surface smooth.

### 3.4 INSTALLATION OF OUTDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.
- B. Install outdoor units on support structures indicated on Drawings.
- C. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
  - 1. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 2. Grouting: Place grout under equipment supports and make bearing surface smooth.
- D. Roof-Mounted Installations: Install outdoor units on equipment supports specified in Section 07 72 00 "Roof Accessories." Anchor units to supports with removable, stainless steel fasteners.

### 3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping and tubing to permit valve servicing.
- F. Install piping and tubing at indicated slopes.
- G. Install piping and tubing free of sags.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping and tubing to allow application of insulation.



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- J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.
- K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."
- L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 "Escutcheons for HVAC Piping."

3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

- A. General Requirements for Drain Piping and Tubing:
  - 1. Install a union in piping at each threaded unit connection.
  - 2. Install an adjustable stainless steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
  - 3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:
    - a. Details indicated on Drawings.
    - b. Manufacturer's requirements.
    - c. Governing codes.
    - d. In the absence of requirements, comply with requirements of ASHRAE handbooks.
  - 4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
  - 5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.
- B. Gravity Drains:
  - 1. Slope piping from unit connection toward drain termination at a constant slope of not less than one percent.
- C. Pumped Drains:
  - 1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.



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3.7 INSTALLATION OF REFRIGERANT PIPING

A. Refrigerant Tubing Kits:

1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.
2. Support tubing using hangers and supports indicated at intervals not to exceed 5 feet (1.5 m). Minimum rod size, 1/4 inch (6.4 mm).
3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.

B. Install refrigerant piping according to ASHRAE 15 and governing codes.

C. Select system components with pressure rating equal to or greater than system operating pressure.

D. Install piping as short and direct as possible, with a minimum number of joints and fittings.

E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 13 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

F. Install refrigerant piping and tubing in protective conduit where installed belowground.

G. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

H. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:

1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps to entrain oil in vertical runs.
4. Liquid lines may be installed level.

I. When brazing, remove or protect components that could be damaged by heat.

J. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

K. Joint Construction:

1. Ream ends of tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.



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3. Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
  - a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
  - b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

### 3.8 INSTALLATION OF PIPING AND TUBING INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Installation to maintain a continuous vapor barrier.
- B. Insulation Installation on Pipe Fittings and Elbows:
  1. Install mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Valves and Pipe Specialties:
  1. Install preformed valve covers manufactured of same material as pipe insulation when available.
  2. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
  1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- E. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches (300 mm) o.c. and at end joints.

### 3.9 INSTALLATION OF DUCT, ACCESSORIES, AND AIR OUTLETS

- A. Where installing ductwork adjacent to equipment, allow space for service and maintenance.



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- B. Comply with requirements for metal ducts specified in Section 23 31 13 "Metal Ducts."
- C. Comply with requirements for nonmetal ducts specified in Section 23 31 16 "Nonmetal Ducts."
- D. Comply with requirements for air duct accessories specified in Section 23 33 00 "Air Duct Accessories."
- E. Comply with requirements for flexible ducts specified in Section 23 33 46 "Flexible Ducts."
- F. Comply with requirements for air diffusers specified in Section 23 37 13.13 "Air Diffusers."
- G. Comply with requirements for registers and grilles specified in Section 23 37 13.23 "Registers and Grilles."

3.10 ELECTRICAL CONNECTIONS

- A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.
- B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.
  - 1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.
- C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.
- D. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
- E. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" for grounding connections.
- F. Install nameplate or acrylic label with self-adhesive back for each electrical connection indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate shall be laminated phenolic layers of black with engraved white letters. Letters at least 1/2 inch (13 mm) high.
  - 2. Locate nameplate or label where easily visible.
- G. Comply with requirements in Section 26 05 33.13 "Conduits for Electrical Systems" for raceway selection and installation requirements for conduits as supplemented or revised in this Section.



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- H. Comply with requirements in Section 26 05 33.16 "Boxes and Covers for Electrical Systems" for box selection and installation requirements for boxes as supplemented or revised in this Section.
- I. Comply with requirements in Section 26 05 33.23 "Surface Raceways for Electrical Systems" for wireways selection and installation requirements for wireways as supplemented or revised in this Section.
  - 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
  - 2. Outlet boxes for cables shall be no smaller than 4 inches (102 mm) square by 1-1/2 inches (38 mm) deep with extension ring sized to bring edge of ring to within 1/8 inch (3.1 mm) of the finished wall surface.
  - 3. Flexible metal conduit shall not be used.
- J. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- K. Install manufactured conduit sweeps and long-radius elbows if possible.
- L. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

### 3.11 SOFTWARE

- A. Cybersecurity:
  - 1. Software:
    - a. Coordinate security requirements with IT department.
    - b. Ensure that latest stable software release is installed and properly operating.
    - c. Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols at least eight characters in length. Record passwords and turn over to party responsible for system operation and administration.
  - 2. Hardware:
    - a. Coordinate location and access requirements with IT department.
    - b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
    - c. Disable dual network connections.

### 3.12 INSTALLATION OF SYSTEM CONTROL CABLE

- A. Comply with NECA 1.



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B. Installation Method:

1. Install cables in raceways except as follows:
  - a. Within equipment and associated control enclosures.
  - b. In accessible ceiling spaces where open cable installation method may be used.
  - c. In gypsum board partitions where cable may be enclosed within wall cavity.
2. Conceal raceway and cables except in unfinished spaces.

C. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable.
5. Cables serving a common system may be grouped in a common raceway. Install control cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles or access panels.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals.
15. Do not bend cables in a radius less than 10 times the cable OD.
16. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
17. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

D. Balanced Twisted-Pair Cable Installation:



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1. Comply with TIA-568-C.2.
2. Do not untwist balanced twisted-pair cables more than 1/2 inch (13 mm) at the point of termination to maintain cable geometry.

E. Open-Cable Installation:

1. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 30 inches (760 mm) apart.
2. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources: Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded cable from potential EMI sources including electrical power wiring and equipment.

3.13 FIRESTOPPING

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.14 GROUNDING INSTALLATION

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.15 IDENTIFICATION

- A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."
- B. Identify system electrical and controls components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
  1. Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.



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3.16 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.
1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.
    - a. Additional factory-authorized representatives may assist with completion of certain activities only if supervised by manufacturer's employee. A factory-authorized representative shall not provide assistance without manufacturer's employee supervision.
  2. Kick-off Meeting:
    - a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
    - b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
    - c. Meeting shall cover the following as a minimum requirement:
      - 1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
      - 2) Manufacturer's installation requirements specific to systems being installed.
      - 3) Review of all relevant VRF HVAC system submittals, including delegated design submittals.
      - 4) Required field activities related installation of VRF HVAC system.
      - 5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.
  3. Site Visits: Activities for each site visit shall include the following:
    - a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
    - b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
    - c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
    - d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.
    - e. Issue a report for each visit, documenting the visit.



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- 1) Report to include name and contact information of individual making the visit.
  - 2) Date(s) and time frames while on-site.
  - 3) Names and contact information of people meeting with while on-site.
  - 4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.
4. Final Inspection before Startup:
- a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.
  - b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
  - c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
  - d. Inspection reports for indoor units shall include, but not be limited to, the following:
    - 1) Unit designation on Drawings.
    - 2) Manufacturer model number.
    - 3) Serial number.
    - 4) Network address, if applicable.
    - 5) Each equipment setting.
    - 6) Mounting, supports, and restraints properly installed.
    - 7) Proper service clearance provided.
    - 8) Wiring and power connections correct.
    - 9) Line-voltage reading(s) within acceptable range.
    - 10) Wiring and controls connections correct.
    - 11) Low-voltage reading(s) within an acceptable range.
    - 12) Controller type and model controlling unit.
    - 13) Controller location.
    - 14) Temperature settings and readings within an acceptable range.
    - 15) Humidity settings and readings within an acceptable range.
    - 16) Condensate removal acceptable.
    - 17) Fan settings and readings within an acceptable range.
    - 18) Unit airflow direction within an acceptable range.
    - 19) If applicable, fan external static pressure setting.
    - 20) Filter type and condition acceptable.
    - 21) Noise level within an acceptable range.
    - 22) Refrigerant piping properly connected and insulated.



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- 23) Condensate drain piping properly connected and insulated.
  - 24) If applicable, ductwork properly connected.
  - 25) If applicable, external interlocks properly connected.
  - 26) Remarks.
- e. Inspection reports for outdoor units shall include, but not be limited to, the following:
- 1) Unit designation on Drawings.
  - 2) Manufacturer model number.
  - 3) Serial number.
  - 4) Network address, if applicable.
  - 5) Each equipment setting.
  - 6) Mounting, supports, and restraints properly installed.
  - 7) Proper service clearance provided.
  - 8) Wiring and power connections correct.
  - 9) Line-voltage reading(s) within acceptable range.
  - 10) Wiring and controls connections correct.
  - 11) Low-voltage reading(s) within an acceptable range.
  - 12) Condensate removal acceptable.
  - 13) Noise level within an acceptable range.
  - 14) Refrigerant piping properly connected and insulated.
  - 15) Condensate drain piping properly connected and insulated.
  - 16) Remarks.
- f. Inspection reports for indoor, dedicated outdoor air ventilation units shall include, but not be limited to, the following:
- 1) Unit designation on Drawings.
  - 2) Manufacturer model number.
  - 3) Serial number.
  - 4) Network address, if applicable.
  - 5) Each equipment setting.
  - 6) Mounting, supports, and restraints properly installed.
  - 7) Proper service clearance provided.
  - 8) Wiring and power connections correct.
  - 9) Line-voltage reading(s) within acceptable range.
  - 10) Wiring and controls connections correct.
  - 11) Low-voltage reading(s) within an acceptable range.
  - 12) Controller type and model controlling unit.
  - 13) Controller location.
  - 14) Temperature settings and readings within an acceptable range.
  - 15) Humidity settings and readings within an acceptable range.
  - 16) Condensate removal acceptable.
  - 17) Fan settings and readings within an acceptable range.
  - 18) Fan external static pressure setting.
  - 19) Filter type and condition acceptable.
  - 20) Noise level within an acceptable range.



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- 21) Refrigerant piping properly connected and insulated.
- 22) Condensate drain piping properly connected and insulated.
- 23) Automatic dampers properly installed and operating.
- 24) Ductwork properly connected.
- 25) If applicable, external interlocks properly connected.
- 26) Remarks.

g. Inspection reports for energy recovery ventilators shall include, but not be limited to, the following:

- 1) Unit designation on Drawings.
- 2) Manufacturer model number.
- 3) Serial number.
- 4) Network address, if applicable.
- 5) Each equipment setting.
- 6) Mounting, supports, and restraints properly installed.
- 7) Proper service clearance provided.
- 8) Wiring and power connections correct.
- 9) Line-voltage reading(s) within acceptable range.
- 10) Wiring and controls connections correct.
- 11) Low-voltage reading(s) within an acceptable range.
- 12) Controller type and model controlling unit.
- 13) Controller location.
- 14) Temperature settings and readings within an acceptable range.
- 15) Humidity readings.
- 16) Condensate removal acceptable.
- 17) Fan settings and readings within an acceptable range.
- 18) Fan external static pressure setting.
- 19) Filter type and condition acceptable.
- 20) Noise level within an acceptable range.
- 21) Automatic dampers properly installed and operating.
- 22) Ductwork properly connected.
- 23) If applicable, external interlocks properly connected.
- 24) Remarks.

h. Inspection reports for hydronic units shall include, but not be limited to, the following:

- 1) Unit designation on Drawings.
- 2) Manufacturer model number.
- 3) Serial number.
- 4) Network address, if applicable.
- 5) Each equipment setting.
- 6) Mounting, supports, and restraints properly installed.
- 7) Proper service clearance provided.
- 8) Wiring and power connections correct.
- 9) Line-voltage reading(s) within acceptable range.
- 10) Wiring and controls connections correct.



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- 11) Low-voltage reading(s) within an acceptable range.
- 12) Controller type and model controlling unit.
- 13) Controller location.
- 14) Temperature settings and readings within an acceptable range.
- 15) Condensate removal acceptable.
- 16) Noise level within an acceptable range.
- 17) Refrigerant piping properly connected and insulated.
- 18) Hydronic piping properly connected and insulated.
- 19) Proof of water flow checked for proper operation.
- 20) Condensate drain piping properly connected and insulated.
- 21) If applicable, external interlocks properly connected.
- 22) Remarks.

- i. Installer shall provide manufacturer with the requested documentation and technical support during inspection.
- j. Installer shall correct observed deficiencies found by the inspection.
- k. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.
- l. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
- m. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.2 times VRF HVAC system operating pressure, but not less than 600 psig (4137 kPa), using Insert test medium.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
4. Prepare test report to record the following information for each test:



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- a. Name of person starting test, company name, phone number, and e-mail address.
  - b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
  - c. Detailed description of extent of tubing tested.
  - d. Date and time at start of test.
  - e. Test pressure at start of test.
  - f. Outdoor temperature at start of test.
  - g. Name of person ending test, company name, phone number, and e-mail address.
  - h. Date and time at end of test.
  - i. Test pressure at end of test.
  - j. Outdoor temperature at end of test.
  - k. Remarks:
5. Submit test reports for Project record.
- D. Refrigerant Tubing Evacuation Testing:
1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
  2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
  3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour(s) with no change.
  4. Prepare test report to record the following information for each test:
    - a. Name of person starting test, company name, phone number, and e-mail address.
    - b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
    - c. Detailed description of extent of tubing tested.
    - d. Date and time at start of test.
    - e. Test pressure at start of test.
    - f. Outdoor temperature at start of test.
    - g. Name of person ending test, company name, phone number, and e-mail address.
    - h. Date and time at end of test.
    - i. Test pressure at end of test.
    - j. Outdoor temperature at end of test.
    - k. Remarks:
  5. Submit test reports for Project record.
  6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.
- E. System Refrigerant Charge:



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1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
  2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
  3. System refrigerant charging shall be witnessed by system manufacturer's representative.
  4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.
- F. Products will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

### 3.17 STARTUP SERVICE

- A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.
1. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
  2. Complete startup service of each separate system.
  3. Complete system startup service according to manufacturer's written instructions.
- B. Startup checks shall include, but not be limited to, the following:
1. Check control communications of equipment and each operating component in system(s).
  2. Check each indoor unit's response to demand for cooling and heating.
  3. Check each indoor unit's response to changes in airflow settings.
  4. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.
  5. Check sound levels of each indoor and outdoor unit.
  6. Insert startup check.
- C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.
1. Installer shall correct deficiencies found during startup service for reverification.
- D. System Operation Report:
1. After completion of startup service, manufacturer shall issue a report for each separate system.
  2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
  3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.



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- a. All available system operating parameters shall be included in the information submitted.

E. Witness:

- 1. Invite Commissioning Agent to witness startup service procedures.
- 2. Provide written notice not less than 20 business days before start of startup service.

3.18 ADJUSTING

- A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.
- C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.
- D. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.19 PROTECTION

- A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.
- B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.
- C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.
- D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.20 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include four service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as



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required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.21 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
  - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.22 DEMONSTRATION

- A. Engage a VRF HVAC system manufacturer's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.
- B. Instructor:
  - 1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.
  - 2. Instructor's credentials shall be submitted for review by Commissioning Agent before scheduling training.
  - 3. Instructor(s) primary job responsibility shall be Owner training.
  - 4. Instructor(s) shall have not less than three years of training experience with VRF HVAC system manufacturer and past training experience on at least three projects of comparable size and complexity.
- C. Schedule and Duration:
  - 1. Schedule training with Owner at least 20 business days before first training session.
  - 2. Training shall occur before Owner occupancy.
  - 3. Training shall be held at mutually agreed date and time during normal business hours.
  - 4. Each training day shall not exceed eight hours of training. Daily training schedule shall allow time for one -hour lunch period and 15 -minute break after every two hours of training.
  - 5. Perform not less than eight total hours of training.
- D. Location: Owner shall provide a suitable on-site location to host classroom training.



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- E. Training Attendees: Assume three people.
- F. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.
- G. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.
- H. Training Materials: Provide training materials in electronic format to each attendee.
  - 1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
  - 2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.
- I. Acceptance: Obtain Commissioning Agent written acceptance that training is complete and requirements indicated have been satisfied.

**END OF SECTION 23 81 29**



## SECTION 26 05 00.1 - COMMON WORK RESULTS FOR ELECTRICAL

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section covers and applies to all work specified in Division 26 (and 27 & 28).
- B. Compliance Reviews: The Contractor and equipment vendor shall provide a Compliance Review with the bid proposal of the applicable Drawings, Specifications and Addenda and for all equipment and alternates listed hereinafter for this Project. The Compliance Review will be a paragraph-by-paragraph review of the Specifications with the following information, "C", "D", "E" or "N/A", marked for each Specification section paragraph in the margin of the Specification and any subsequent Addenda.
  - 1. "C": Comply with no exceptions.
  - 2. "D": Comply with minor deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
  - 3. "E": Exception. Equipment, product or material does not comply. For each and every exception, provide a numbered footnote with reasons for the exception for the Owner's consideration and possible alternatives.
  - 4. "N/A": The Specification paragraph does not apply to the proposed equipment, material or product.
  - 5. Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the equipment proposed for this project is in complete compliance with the Contract Documents. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction do not release the Contractor from being in complete compliance, unless the exception or deviation has been specifically noted (explicitly, not by implication) in the Compliance Review.
- C. Work Included: Materials, equipment, fabrication, installation and tests for fully operational and safe systems, including all necessary materials, appurtenances and features whether specified or shown on drawings or not, in conformity with applicable codes and authorities having jurisdiction for the following:
  - 1. Electrical work specified in all sections within Division 26 (and 27 & 28) of these specifications, including, but not limited to:
    - a. Short circuit analysis and protective device coordination study.
    - b. Primary underground service ducts from the point of connection to the Serving Agency to the transformer vault, building main switchboard.
    - c. Equipment for serving agency facilities shall be furnished and installed in accordance with the requirements of the Serving Utility. Transformers, primary cable, and utilization equipment will be furnished and installed by the Serving Agency.



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- d. Lighting and power distribution facilities, including busways, main switchboard with metering, transformers, distribution boards, panelboards with feeders, motor control centers, branch circuit wiring, connections to outlets, and wiring devices.
- e. Lighting fixtures and lamps.
- f. Motor and other power-consuming equipment connections from motor control centers or distribution apparatus to equipment.
- g. Telephone conduit system, including underground service facilities, riser and lateral extension conduits, and facilities required in terminal room in accordance with the requirements of the Telephone Utility.
- h. Elevator and escalator feeders.
- i. Control, alarm and interlock wiring for mechanical equipment, where indicated.
- j. Electrical grounding system.
- k. Emergency power and lighting system, including engine-generator set complete with oil system and power transfer capability.
- l. Vibration and seismic controls for electrical systems.
- m. Life safety system including ADA requirements.
- n. Lightning protection.
- o. Cable tray system.
- p. Water leak detection.
- q. Low voltage system (PA, NC, MATV, CCTV, CATV, Security, etc.)
- r. Excavation, backfilling and compacting for the Electrical Work.
- s. Cutting and patching for the Electrical Work.
- t. Adjustment and testing of the Electrical Work.
- u. Examine the drawings and specifications of other Divisions and provide electrical service for all equipment, devices and controls noted therein, unless work specifically is not included.
- v. Lighting control system.
- w. Dimming system.
- x. Uninterruptable power supply (UPS) system.
- y. Underfloor power and telephone/telecom distribution system.

## 1.2 UTILITY CONNECTIONS

- A. Finalize electrical service arrangements including verification of locations and details with the Serving Agency.
- B. Verify locations of facilities and details with the Telephone Utility.
  - 1. Final telephone service arrangements will be made by the Owner.
- C. In addition to the requirements shown on the drawings and stated herein, the work shall comply with the following:
  - 1. Construction Standards and Service Requirements of the respective utilities including any supplementary drawings issued by the utilities.
  - 2. Be subjected to inspection approval of these utilities.



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- D. Electrical service facilities shall consist of furnishing and installing concrete encased primary conduits, transformer vault appurtenances and secondary service including utility meter in accordance with the arrangement, details, and locations shown on the drawings and described herein and as required by the utility company.
  - 1. Transformer vault: Furnish and install conduits and ducts with terminations, mounting inserts, lighting fixtures and wiring devices, conduits with outlets, wire with connections for lighting facilities, grounding conductors and fittings and other work as required by the Serving Agency.

### 1.3 ELECTRICAL SYSTEM CHARACTERISTICS

- A. Service: 480/277 volts, 3 phase, 4 wire with grounded neutral.
- B. High intensity discharge and fluorescent lighting: 277 volts.
- C. Motors ½ horsepower and above: 480 volts, 3 phase.
- D. Fractional horsepower motors less than ½ horsepower: 120 volts single phase.
- E. Incandescent lighting and general receptacles will be supplied at 120 volts.

## PART 2 - PRODUCTS

### 2.1 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## PART 3 - EXECUTION

### 3.1 HOUSEKEEPING PADS AND FOUNDATIONS

- A. Concrete work required for housekeeping pads and foundations will be provided by General Construction Work. Comply with the requirement for concrete base specified in Division 03 section.
  - 1. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for anchoring equipment to the concrete base.



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4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  5. Bolt equipment to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.
  6. Refinish damaged or scratched surfaces.
  7. Provide 24 inch wide insulating mat in front of operable electrical equipment and in front and rear of free standing ones.
  8. Tighten all bolted connections prior to energizing.
  9. Provide fuse cabinet with specified number of fuses of each type.
  10. Provide special tools as required for routing maintenance and inspection.
- B. Furnish required dimensional drawings and specify locations. Minimum height of housekeeping pads shall be 4 inches and shall extend out 6 inches from the footprint of the equipment.
- C. Furnish anchor bolts and sleeves, and verify accuracy of installation.
- D. Provide for:
1. Switchboards, switchgears, unit substation and floor mounted ATS.
  2. Standby power plants.
  3. Floor mounted transformers.
  4. Motor control centers.
  5. Outdoor light fixture standards.
  6. UPS.
  7. All other floor mounted equipment.

**END OF SECTION 26 05 00.1**



## SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Copper building wire.
2. Aluminum building wire.
3. Metal-clad cable, Type MC.
4. Mineral-insulated cable, Type MI.
5. Tray cable, Type TC.
6. Fire-alarm wire and cable.
7. Connectors and splices.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 05 13 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35 000 V.
3. Section 26 05 23 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
3. Product Data: For solvents and adhesives, indicating VOC content.

C. Product Schedule: Indicate type, use, location, and termination locations.

#### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.



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PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alpha Wire Company.
  2. American Bare Conductor.
  3. Belden Inc.
  4. Cerro Wire LLC.
  5. Encore Wire Corporation.
  6. General Cable; Prysmian Group North America.
  7. Okonite Company (The).
  8. Service Wire Co.
  9. Southwire Company.
  10. WESCO.
- C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 or ASTM B496 for stranded conductors.
- E. Conductor Insulation:
1. Type RHH and Type RHW-2: Comply with UL 44.
  2. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
  3. Type THHN and Type THWN-2: Comply with UL 83.
  4. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
  5. Type XHHW-2: Comply with UL 44.
- F. Shield:
1. Type TC-ER: Cable designed for use with ASDs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.



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2.2 ALUMINUM BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less. Use allowed for feeders rated 400 amps and larger only.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Alpha Wire Company.
  - 2. American Bare Conductor.
  - 3. Belden Inc.
  - 4. Cerro Wire LLC.
  - 5. Encore Wire Corporation.
  - 6. General Cable; Prysmian Group North America.
  - 7. Okonite Company (The).
  - 8. Southwire Company.
  - 9. WESCO.
- C. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Aluminum, complying with ASTM B800 and ASTM B801.
- E. Conductor Insulation:
  - 1. Type THHN and Type THWN-2: Comply with UL 83.
  - 2. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
  - 3. Type XHHW-2: Comply with UL 44.

2.3 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AFC Cable Systems; Atkore International.
  - 2. Alpha Wire Company.
  - 3. American Bare Conductor.
  - 4. Belden Inc.
  - 5. Encore Wire Corporation.



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6. General Cable; Prysmian Group North America.
7. Okonite Company (The).
8. Service Wire Co.
9. Southwire Company.
10. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

H. Armor: Steel, interlocked.

I. Jacket: PVC applied over armor.

2.4 MINERAL-INSULATED CABLE, TYPE MI

A. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. KME America, Inc.
2. nVent (PYROTENAX).
3. Pentair.
4. Watlow Electric Manufacturing Company.

C. Standards:



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1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  2. UL 2196 for fire resistance.
  3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper.
- E. Insulation: Compressed magnesium oxide.
- F. Sheath: Copper.

2.5 TRAY CABLE, TYPE TC

- A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alpha Wire Company.
  2. Belden Inc.
  3. Encore Wire Corporation.
  4. General Cable; Prysmian Group North America.
  5. Okonite Company (The).
  6. Service Wire Co.
  7. Southwire Company.
  8. WESCO.
- C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  2. Comply with UL 1277.
  3. Comply with ICEA S-73-532/NEMA WC 57 for Type TC cables used for control, thermocouple extension, and instrumentation.
  4. Comply with ICEA S-95-658/NEMA WC 70 for Type TC cables used for power distribution.
  5. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide" unless noted otherwise.
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Ground Conductor: Insulated.
- F. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.



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- G. Shield: As indicated below.
- H. Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.
- I. Construction Types:
  - 1. Type 1, Multiconductor Control Cable
    - a. Conductors: 14 AWG, seven-strand copper
    - b. Insulation: THHN/THWN to UL 1581, rated VW-1.
    - c. Conductor group bound with spiral wrap of barrier tape.
    - d. Color Code: In accordance with ICEA S-58-679, Method 1, Table 2.
    - e. Passes UL 1685 70,000 BTU/hr. test.
    - f. Allowed conductor quantities: 3, 5, 7, 12, 19, 25 and 37.
  - 2. Type 3, 16 AWG, twisted and shielded pair Instrumentation Cable
    - a. Conductors: Bare soft annealed copper, Class B concentric stranding per ASTM B8.
    - b. Drain Wire: 20 AWG seven-strand tinned copper.
    - c. Insulation: 15-mil PVC
    - d. Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
    - e. Color Code: Pair conductors black and red.
  - 3. Type 4, 16 AWG, twisted and shielded triad Instrumentation Cable. Single triad designed for noise rejection for process control, computer or data logger applications.
    - a. Conductors: Bare soft annealed copper, Class B concentric stranding per ASTM B8.
    - b. Drain Wire: 20 AWG seven-strand tinned copper.
    - c. Insulation: 15-mil PVC
    - d. Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
    - e. Color Code: Triad conductors black, red and blue.
  - 4. Type 5, 18 AWG, Multi-twisted shielded pairs, with a Common Overall Shield, Instrumentation Cable: Designed for use as instrumentation process control, and computer cable.
    - a. Conductors: Bare soft annealed copper, Class B concentric stranding per ASTM B8.
    - b. Drain Wire:
      - 1) Pairs: 20 AWG seven-strand tinned copper.
      - 2) Overall Shield: 18 AWG seven-strand tinned copper.
    - c. Insulation: 15-mil PVC
    - d. Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage. Pair and overall shields to be electrically isolated.
    - e. Color Code: Pair conductors black and red with white pair numerically printed for group identification.



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- f. Allowed Pair Quantities: 4, 8, 12, 16, 24, 36 and 50 pairs.
- 5. Type 6, 18 AWG, Multi-twisted Pairs with Common Overall Shield  
Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable.
  - a. Conductors: Bare soft annealed copper, Class B concentric stranding per ASTM B8.
  - b. Drain Wire: 18 AWG seven-strand tinned copper.
  - c. Insulation: 15-mil PVC
  - d. Shield: 2.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
  - e. Color Code: Pair conductors black and red with white pair numerically printed for group identification.
  - f. Allowed Pair Quantities: 4, 8, 12, 16, 24, 36 and 50 pairs.

## 2.6 FIRE-ALARM WIRE AND CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Allied Wire & Cable Inc.
  - 2. CommScope, Inc.
  - 3. Comtran Corporation.
  - 4. Genesis Cable Products; Honeywell International, Inc.
  - 5. nVent (PYROTENAX).
  - 6. Prysmian Cables and Systems; Prysmian Group North America.
  - 7. Radix Wire.
  - 8. Rockbestos-Suprenant Cable Corp.
  - 9. Superior Essex Inc.
  - 10. West Penn Wire.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
  - 1. Lead Content: Less than 300 parts per million.
- C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
  - 1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
  - 2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
  - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.



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2.7 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. 3M Electrical Products.
  2. ABB, Electrification Products Division.
  3. AFC Cable Systems; Atkore International.
  4. Gardner Bender.
  5. Hubbell Incorporated, Power Systems.
  6. Ideal Industries, Inc.
  7. ILSCO.
  8. NSi Industries LLC.
  9. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
  10. Service Wire Co.
  11. TE Connectivity Ltd.
- C. Connectors and Terminations:
1. Nylon, Self-Insulated Crimp Connectors
  2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator
  3. Self-Insulated, Freespring Wire Connector (Wire Nuts)
  4. Self-Insulated, Set Screw Wire Connector:
    - a. Two-piece compression type with set screw in brass barrel.
    - b. Insulated by insulator cap screwed over brass barrel.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
1. Material: Copper.
  2. Type: Two hole with long barrels.
  3. Termination: Compression.
  4. Suitable for use with 75 degrees C wire a full Code 75 degrees C ampacity.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders:
1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.



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2. Copper for feeders smaller than 400 amps; copper or aluminum for feeders 400 amps and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway Metal-clad cable, Type MC.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace:  
Type THHN/THWN-2, single conductors in raceway Metal-clad cable, Type MC.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground:  
Type XHHW-2, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway Metal-clad cable, Type MC.

F. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway Metal-clad cable, Type MC.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground:  
Type XHHW-2, single conductors in raceway.

I. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway Metal-clad cable, Type MC.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

K. ASD Output Circuits: Type XHHW-2 in metal conduit.



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3.3 INSTALLATION, GENERAL

- A. Conductor and cable sizing is to be based on copper conductors, unless noted otherwise for conductors 600 Volt and below.
- B. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- C. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" or Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" prior to pulling conductors and cables. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.
- D. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4 inch smaller than raceway inside diameter.
- E. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values. Ideal Yellow #77 is NOT allowed.
- F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- H. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- I. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

- A. Comply with NFPA 72.
- B. Wiring Method: Install wiring in metal pathway according to Section 27 05 28.29 "Hangers and Supports for Communications Systems."
  - 1. Install plenum cable in environmental airspaces, including plenum ceilings.
  - 2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.



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- a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
  - 3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
  - 4. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.
  - C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
  - D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
  - E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.
  - F. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.
  - G. Wiring to Remote Alarm Transmitting Device: 1 inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.
- 3.5 CONNECTIONS
- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
  - B. Cable Lugs: Provide with correct number of holes, bolt size, and center- to-center spacing as required by equipment terminals.
  - C. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.



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1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- D. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch of slack.
- E. Install wire nuts only on solid conductors. Wire nuts are not allowed on stranded conductors or instrumentation conductors smaller than #14 AWG.
- F. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
- G. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.
- H. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.
- I. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.
- J. Place no more than one conductor in any single-barrel pressure connection.
- K. Install crimp connectors with tools approved by connector manufacturer.
- L. Compression Lugs:
  1. Attach with a tool specifically designed for purpose. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
  2. Do not use plier type crimpers.
- M. Do not use soldered mechanical joints.
- N. Splices and Terminations:
  1. Insulate uninsulated connections.
  2. Indoors: UL listed general purpose, flame retardant tape or single wall heat shrink.
  3. Outdoors, Dry Locations: UL listed flame retardant, cold-and weather-resistant tape or single wall heat shrink.
  4. Below Grade and Wet or Damp Locations: UL listed dual wall heat shrink.
- O. Cap spare conductors with UL listed end caps.
- P. Cabinets, Panels, and Motor Control Centers:
  1. Remove surplus wire, braid and secure.



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2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.
3. Group multi-wire circuits at least once within enclosure per CEC 210.4(D) unless exception applies.

Q. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
4. Where connections of cables installed under this section are to be made under Section 26 09 14 Power System Supervisory Control and Data Acquisition, leave pigtails of adequate length for bundled connections.
5. Cable Protection:
  - a. Maintain integrity of shielding of instrumentation cables.
  - b. Ensure grounds do not occur because of damage to jacket over shields.

- R. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.6 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.
- C. Power Conductor Color Coding
  1. Conductors below 600V: Provide manufacturer applied colored insulation on conductors.
  2. Colors

System	Conductor	Color
All System	Equipment Grounding	Green



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240/120 Volts, Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts, Three-Phase, Four-Wire, Delta, Center Tap, Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480/277 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow

D. Circuit Identification:

1. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, pad mounted switchgear, switchboards, control panels, pull boxes, and terminal boxes.
2. Circuits Appearing in Circuit Schedules: Identify using circuit schedule designations.
3. Circuits Not Appearing in Circuit Schedules:
  - a. Assign circuit name based on device or equipment at load end of circuit.
  - b. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.
4. Method:
  - a. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
  - b. Cables and Conductors 2 AWG and Larger:
    - 1) Identify with marker plates or tie-on cable marker tags.
    - 2) Attach with nylon tie cord.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."



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3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
  2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance, feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:
    - a. Power distribution equipment rated at 400 A and above.
  3. Perform each of the following visual and electrical tests:
    - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    - b. Test bolted connections for high resistance using one of the following:
      - 1) A low-resistance ohmmeter.
      - 2) Calibrated torque wrench.
      - 3) Thermographic survey.
    - c. Inspect compression-applied connectors for correct cable match and indentation.
    - d. Inspect for correct identification.
    - e. Inspect cable jacket and condition.
    - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
    - g. Continuity test on each conductor and cable.
    - h. Uniform resistance of parallel conductors.
  4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
    - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.



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- 5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
  - 1. Procedures used.
  - 2. Results that comply with requirements.
  - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

**END OF SECTION 26 05 19**



## SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Support, anchorage, and attachment components.
2. Fabricated metal equipment support assemblies.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified structural professional engineer to design hanger and support system.
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame Rating: Class 1.
  2. Self-extinguishing according to ASTM D635.

#### 2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ABB, Electrification Products Division.
    - b. Allied Tube & Conduit; Atkore International.
    - c. B-line; Eaton, Electrical Sector.
    - d. CADDY; nVent.
    - e. Flex-Strut Inc.
    - f. Gripple Inc.
    - g. G-Strut.
    - h. Haydon Corporation.
    - i. Metal Ties Innovation.
    - j. MIRO Industries.
    - k. Unistrut; Atkore International.
    - l. Wesanco, Inc.



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2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  3. Material for Channel, Fittings, and Accessories: Galvanized steel.
  4. Channel Width: Selected for applicable load criteria.
  5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 9/16 inch diameter holes at a maximum of 8 inch on center, in at least one surface.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit; Atkore International.
    - b. B-line; Eaton, Electrical Sector.
    - c. Fabco Plastics Wholesale Limited.
    - d. G-Strut.
    - e. Haydon Corporation.
    - f. Seasafe, Inc.; AMICO, a Gibraltar Industries Company.
  2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  3. Channel Width: Selected for applicable load criteria.
  4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
  5. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
  6. Rated Strength: Selected to suit applicable load criteria.
  7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:



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1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Hilti, Inc.
    - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
    - 3) MKT Fastening, LLC.
    - 4) Simpson Strong-Tie Co., Inc.
2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) B-line; Eaton, Electrical Sector.
    - 2) Empire Tool and Manufacturing Co., Inc.
    - 3) Hilti, Inc.
    - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
    - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
6. Toggle Bolts: Stainless steel springhead type.
7. Hanger Rods: Threaded steel.

## 2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

## PART 3 - EXECUTION

### 3.1 SELECTION

- A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
  1. NECA NEIS 101
  2. NECA NEIS 105.



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- B. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceway and Boxes for Electrical Systems."
- C. Provide vibration and seismic controls with hangers and supports in accordance with requirements specified in "Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERM as scheduled in NECA NEIS 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size must be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted [or other ]support system, sized so capacity can be increased by at least 20 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

**END OF SECTION 26 05 29**



## SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Type EMT-S raceways and elbows.
2. Type ERMC-S raceways, elbows, couplings, and nipples.
3. Type FMC-S raceways.
4. Type LFMC raceways.
5. Fittings for conduit, tubing, and cable.
6. Threaded metal joint compound.
7. Surface metal raceways and fittings.
8. Wireways and auxiliary gutters.
9. Metallic outlet boxes, device boxes, rings, and covers.
10. Termination boxes.
11. Cabinets, cutout boxes, junction boxes, pull boxes, and miscellaneous enclosures.
12. Cover plates for device boxes.

### PART 2 - PRODUCTS

#### 2.1 TYPE EMT-S RACEWAYS AND ELBOWS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 797 and UL Category Control Number FJMX.

B. Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Allied Tube & Conduit; Atkore International.
  - b. Calconduit; Atkore International.
  - c. Emerson Electric Co.
  - d. Picoma; Zekelman Industries.
  - e. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
  - f. Topaz Lighting & Electric.
  - g. Western Tube; Zekelman Industries.
  - h. Wheatland Tube; Zekelman Industries.



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2. Material: Steel.
3. Options:
  - a. Exterior Coating: Zinc.
  - b. Interior Coating: Zinc.
  - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.2 TYPE ERM-C-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 6 and UL Category Control Number DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERM-C-S-G), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Allied Tube & Conduit; Atkore International.
  - b. Calconduit; Atkore International.
  - c. Crouse-Hinds; Eaton, Electrical Sector.
  - d. Killark; Hubbell Incorporated, Construction and Energy.
  - e. Patriot Aluminum Products, LLC.
  - f. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
  - g. Topaz Lighting & Electric.
  - h. Western Tube; Zekelman Industries.
  - i. Wheatland Tube; Zekelman Industries.
2. Exterior Coating: Zinc.
3. Options:
  - a. Interior Coating: Zinc.
  - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).

C. PVC-Coated-Steel Electrical Rigid Metal Conduit (ERM-C-S-PVC), Elbows, Couplings, and Nipples (for transitioning from below to above grade stub-ups and for above grade exterior application only):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Bluesteel Services LLC.
  - c. Calbond; Atkore International.
  - d. KorKap; Robroy Industries.
  - e. Perma-Cote; Robroy Industries.
  - f. Plasti-Bond; Robroy Industries.
2. Additional Characteristics:



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- a. Fittings for PVC-Coated Conduit:
  - 1) Minimum coating thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
  - 2) Conduit bodies must be Form 8 with an effective seal and a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 in. of mercury (vacuum) for 72 hours must be available. Conduit bodies must be supplied with plastic-encapsulated stainless steel cover screws.
  - 3) Form 2 inch long or one pipe diameter long, whichever is less, PVC sleeve at openings of female fittings, except unions. Inside sleeve diameter must be matched to outside diameter of metal conduit.
  - 4) PVC coating on the outside of conduit couplings must be protected from tool damage during installation.
  - 5) Female threads on fittings and couplings must be protected by urethane coating.
  - 6) Fittings must be from same manufacturer as conduit.
  - 7) Beam clamps and U bolts must be formed and sized to fit outside diameter of coated conduit. Plastic-encapsulated nuts must cover the exposed portions of threads.
- 3. Options:
  - a. Exterior Coating: PVC complying with NEMA RN 1
  - b. Interior Coating: Zinc.
  - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
  - d. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
  - e. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

## 2.3 TYPE FMC-S AND TYPE FMC-A RACEWAYS

### A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- 2. General Characteristics: UL 1 and UL Category Control Number DXUZ.

### B. Steel Flexible Metal Conduit (FMC-S):

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Electri-Flex Company.
  - c. Topaz Lighting & Electric.
- 3. Material: Steel.



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4. Options:
  - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
  - b. Colors: As indicated on Drawings.

C. Aluminum Flexible Metal Conduit (FMC-A):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Electri-Flex Company.
  - c. Topaz Lighting & Electric.
3. Material: Aluminum.
4. Options:
  - a. Minimum Trade Size: **Metric designator 21 (trade size 3/4).**
  - b. Colors: As indicated on Drawings.

2.4 TYPE LFMC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 360 and UL Category Control Number DXHR.

B. Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Anaconda Sealtite; Anamet Electrical, Inc.
  - c. Electri-Flex Company.
  - d. International Metal Hose Co.
2. Material: Steel.
3. Options:
  - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

C. Stainless Steel Liquidtight Flexible Metal Conduit (LFMC-SS):

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Electri-Flex Company.
2. Material: Stainless steel.
3. Options:



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- a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

## 2.5 FITTINGS FOR CONDUIT, TUBING, AND CABLE

### A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

### B. Fittings for Type ERM, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Crouse-Hinds; Eaton, Electrical Sector.
  - c. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - d. Konkore Fittings; Atkore International.
  - e. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
  - f. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
  - g. Southwire Company.
  - h. Topaz Lighting & Electric.
- 2. General Characteristics: UL 514B and UL Category Control Number DWTT.
- 3. Options:
  - a. Material: Steel.
  - b. Coupling Method: Compression coupling Raintight compression coupling with distinctive color gland nut.
  - c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
  - d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

### C. Fittings for Type EMT Raceways:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Allied Tube & Conduit; Atkore International.
  - c. Calconduit; Atkore International.
  - d. Crouse-Hinds; Eaton, Electrical Sector.
  - e. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - f. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
  - g. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
  - h. Southwire Company.
  - i. Topaz Lighting & Electric.
- 2. General Characteristics: UL 514B and UL Category Control Number FKAV.
- 3. Options:



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- a. Material: Steel.
- b. Coupling Method: Compression coupling Raintight compression coupling with distinctive color gland nut.
- c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
- d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

D. Fittings for Type FMC Raceways:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Fittings Corp. (AMFICO).
  - b. Liquid Tight Connector Co.
  - c. Southwire Company.
- 2. General Characteristics: UL 514B and UL Category Control Number ILNR.

E. Fittings for Type LFMC and Type LFNC Raceways:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Liquid Tight Connector Co.
- 2. General Characteristics: UL 514B and UL Category Control Number DXAS.

2.6 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- 2. General Characteristics: UL 2419 and UL Category Control Number FOIZ.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

- 1. ABB, Electrification Products Division.

2.7 SURFACE METAL RACEWAYS AND FITTINGS

A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- 2. General Characteristics: UL 5 and UL Category Control Number RJBT.



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B. Surface Metal Raceways and Fittings with Metal Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. MonoSystems, Inc.
  - b. Wiremold; Legrand North America, LLC.
  - c. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
2. Options:
  - a. Galvanized steel Aluminum base with snap-on covers.
  - b. Prime coated, ready for field painting.
  - c. Wiring Channels: Dual. Multiple channels must be capable of housing a standard 20 to 30 A NEMA device flush within the raceway.

C. Surface Metal Raceways and Fittings with Nonmetallic Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Union Products International, Inc.
2. Additional Characteristics: UL 94, V-0 requirements for self-extinguishing characteristics.
3. Options:
  - a. Galvanized steel base with snap-on covers.
  - b. Provide texture and color selected by Architect from custom colors.
  - c. Wiring Channels: Dual. Multiple channels must be capable of housing a standard 20 to 30 A NEMA device flush within the raceway.

2.8 WIREWAYS AND AUXILIARY GUTTERS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 870 and UL Category Control Number ZOYX.

B. Metal Wireways and Auxiliary Gutters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. B-line; Eaton, Electrical Sector.
  - c. Hoffman; nVent.
  - d. MonoSystems, Inc.
  - e. Square D; Schneider Electric USA.
  - f. Wiegmann; Hubbell Incorporated, Commercial and Industrial.
2. Additional Characteristics:



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- a. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
  - b. Finish: Manufacturer's standard enamel finish.
3. Options:
- a. Degree of Protection: for interior application Type 1 for exterior application Type 3R unless otherwise indicated.
  - b. Wireway Covers: Screw-cover type unless otherwise indicated.

2.9 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- 2. General Characteristics: UL 514A and UL Category Control Number QCIT.

B. Metallic Outlet Boxes:

- 1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Arlington Industries, Inc.
  - c. Crouse-Hinds; Eaton, Electrical Sector.
  - d. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - e. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.
  - f. Killark; Hubbell Incorporated, Construction and Energy.
  - g. MonoSystems, Inc.
  - h. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
  - i. Pass & Seymour; Legrand North America, LLC.
  - j. Patriot Aluminum Products, LLC.
  - k. Plasti-Bond; Robroy Industries.
  - l. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
  - m. Spring City Electrical Manufacturing Company.
  - n. Topaz Lighting & Electric.
  - o. Wiremold; Legrand North America, LLC.
  - p. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
- 3. Options:
  - a. Material: Sheet steel.
  - b. Sheet Metal Depth: Minimum 2.5 inch.

C. Metallic Conduit Bodies:



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1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Crouse-Hinds; Eaton, Electrical Sector.
  - c. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - d. Killark; Hubbell Incorporated, Construction and Energy.
  - e. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
  - f. Pass & Seymour; Legrand North America, LLC.
  - g. Patriot Aluminum Products, LLC.
  - h. Plasti-Bond; Robroy Industries.
  - i. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
  - j. Topaz Lighting & Electric.

D. Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Arlington Industries, Inc.
  - c. Crouse-Hinds; Eaton, Electrical Sector.
  - d. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - e. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.
  - f. Killark; Hubbell Incorporated, Construction and Energy.
  - g. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
  - h. Patriot Aluminum Products, LLC.
  - i. Plasti-Bond; Robroy Industries.
  - j. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
  - k. Topaz Lighting & Electric.
  - l. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
3. Options:
  - a. Material: Sheet steel.
  - b. Sheet Metal Depth: minimum 2.5 inch.

E. Metallic Floor Boxes and Floor Box Covers:

1. Description: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. AFC Cable Systems; Atkore International.
  - c. Arlington Industries, Inc.
  - d. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - e. FSR Inc.



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- f. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.
- g. Leviton Manufacturing Co., Inc.
- h. Pass & Seymour; Legrand North America, LLC.
- i. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
- j. Wiremold; Legrand North America, LLC.
- k. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

F. Metallic Raised-Floor Boxes and Floor Box Covers:

- 1. Description: Box mounted in raised-floor with floor box cover and other components to complete floor box enclosure.
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Wiremold; Legrand North America, LLC.
  - c. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

G. Metallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:

- 1. Description: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. FSR Inc.
  - b. Wiremold; Legrand North America, LLC.
  - c. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

H. Metallic Concrete Boxes and Covers:

- 1. Description: Box intended for use in poured concrete.
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Crouse-Hinds; Eaton, Electrical Sector.
  - c. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.
  - d. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
  - e. Topaz Lighting & Electric.
  - f. Wiremold; Legrand North America, LLC.

2.10 TERMINATION BOXES

- A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.
- B. Performance Criteria:



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1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 1773 and UL Category Control Number XCKT.

C. Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. B-line; Eaton, Electrical Sector.
  - c. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - d. Erickson Electrical Equipment Company.
  - e. Hoffman; nVent.
  - f. Metron; Hubbell Incorporated, Commercial and Industrial.
  - g. Milbank Manufacturing Co.
  - h. N J Sullivan Company.
  - i. Square D; Schneider Electric USA.
2. Additional Characteristics: Listed and labeled for installation on line side of service equipment.

D. Termination Boxes and Termination Bases for Installation on Load Side of Service Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. B-line; Eaton, Electrical Sector.
  - c. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - d. Erickson Electrical Equipment Company.
  - e. Hoffman; nVent.
  - f. Metron; Hubbell Incorporated, Commercial and Industrial.
  - g. Milbank Manufacturing Co.
  - h. N J Sullivan Company.
  - i. Square D; Schneider Electric USA.
2. Additional Characteristics: Listed and labeled for installation on load side of service equipment.

2.11 CABINETS, CUTOFF BOXES, JUNCTION BOXES, PULL BOXES, AND MISCELLANEOUS ENCLOSURES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:



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- a. Non-Environmental Characteristics: UL 50.
- b. Environmental Characteristics: UL 50E.

B. Indoor Sheet Metal Cabinets:

- 1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Adalet.
  - c. B-line; Eaton, Electrical Sector.
  - d. Crouse-Hinds; Eaton, Electrical Sector.
  - e. Erickson Electrical Equipment Company.
  - f. FSR Inc.
  - g. Hoffman; nVent.
  - h. Killark; Hubbell Incorporated, Construction and Energy.
  - i. Milbank Manufacturing Co.
  - j. N J Sullivan Company.
  - k. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
  - l. Robroy Enclosures; Robroy Industries.
  - m. Siemens Industry, Inc., Building Technologies Division.
  - n. Square D; Schneider Electric USA.
- 3. Additional Characteristics: UL Category Control Number CYIV.
- 4. Options:
  - a. Degree of Protection: **Type 1.**

C. Indoor Sheet Metal Junction and Pull Boxes:

- 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Adalet.
  - b. B-line; Eaton, Electrical Sector.
  - c. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - d. FSR Inc.
  - e. Hoffman; nVent.
  - f. Hubbell Industrial Controls; Hubbell Incorporated, Commercial and Industrial.
  - g. Milbank Manufacturing Co.
  - h. N J Sullivan Company.
  - i. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
  - j. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
  - k. Spring City Electrical Manufacturing Company.
  - l. Square D; Schneider Electric USA.
  - m. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.



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3. Additional Characteristics: UL Category Control Number BGUZ.
4. Options:
  - a. Degree of Protection: Type 1.

D. Indoor Sheet Metal Miscellaneous Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. B-line; Eaton, Electrical Sector.
  - c. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - d. Erickson Electrical Equipment Company.
  - e. Hoffman; nVent.
  - f. Metron; Hubbell Incorporated, Commercial and Industrial.
  - g. Milbank Manufacturing Co.
  - h. N J Sullivan Company.
  - i. Square D; Schneider Electric USA.
2. Additional Characteristics: UL 1773 and UL Category Control Number XCKT.
3. Options:
  - a. Degree of Protection: Type 1.

E. Outdoor Sheet Metal Cabinets:

1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Adalet.
  - c. B-line; Eaton, Electrical Sector.
  - d. Crouse-Hinds; Eaton, Electrical Sector.
  - e. Erickson Electrical Equipment Company.
  - f. FSR Inc.
  - g. Hoffman; nVent.
  - h. Killark; Hubbell Incorporated, Construction and Energy.
  - i. Milbank Manufacturing Co.
  - j. N J Sullivan Company.
  - k. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
  - l. Robroy Enclosures; Robroy Industries.
  - m. Siemens Industry, Inc., Building Technologies Division.
  - n. Square D; Schneider Electric USA.
3. Options:
  - a. Degree of Protection: Type 3R Type 4.

F. Outdoor Sheet Metal Junction and Pull Boxes:



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1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Adalet.
  - b. B-line; Eaton, Electrical Sector.
  - c. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - d. FSR Inc.
  - e. Hoffman; nVent.
  - f. Hubbell Industrial Controls; Hubbell Incorporated, Commercial and Industrial.
  - g. Milbank Manufacturing Co.
  - h. N J Sullivan Company.
  - i. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
  - j. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
  - k. Spring City Electrical Manufacturing Company.
  - l. Square D; Schneider Electric USA.
  - m. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
3. Options:
  - a. Degree of Protection: Type 3R Type 4.

G. Outdoor Cast-Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Adalet.
  - b. Crouse-Hinds; Eaton, Electrical Sector.
  - c. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - d. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
3. Additional Characteristics: UL Category Control Number BGUZ.
4. Options:
  - a. Degree of Protection: Type 3X Type 4.

H. Outdoor Sheet Metal Miscellaneous Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. B-line; Eaton, Electrical Sector.
  - c. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - d. Erickson Electrical Equipment Company.
  - e. Hoffman; nVent.
  - f. Metron; Hubbell Incorporated, Commercial and Industrial.
  - g. Milbank Manufacturing Co.
  - h. N J Sullivan Company.



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- i. Square D; Schneider Electric USA.
- 2. Additional Characteristics: UL 1773 and UL Category Control Number XCKT.
- 3. Options:
  - a. Degree of Protection: Type 3X Type 4.

2.12 COVER PLATES FOR DEVICES BOXES

A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- 2. General Characteristics:
  - a. Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.
  - b. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. Metallic Cover Plates for Device Boxes:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - c. Crouse-Hinds; Eaton, Electrical Sector.
  - d. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
  - e. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.
  - f. Intermatic, Inc.
  - g. Leviton Manufacturing Co., Inc.
  - h. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
  - i. Panduit Corp.
  - j. Pass & Seymour; Legrand North America, LLC.
  - k. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
  - l. Topaz Lighting & Electric.
  - m. Wiremold; Legrand North America, LLC.
  - n. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
- 2. Options:
  - a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
  - b. Wallplate Material: 0.032 inch thick Type 302/304 non-magnetic stainless steel with brushed finish.

PART 3 - EXECUTION

**END OF SECTION 26 05 33**



## SECTION 26 05 36 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Ladder cable tray.
2. Wire-mesh cable tray.
3. Single-rail cable tray.
4. Solid-bottom cable tray.
5. Trough cable tray.
6. Channel cable tray.
7. Fiberglass cable tray.
8. Fiberglass channel cable tray.
9. Cable tray accessories.
10. Warning signs.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified structural professional engineer to design cable tray supports and seismic bracing.

#### 2.2 LADDER CABLE TRAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Products Division.
2. B-line; Eaton, Electrical Sector.
3. Chalfant Manufacturing Company.
4. Cope; Atkore International.
5. MonoSystems, Inc.
6. MP Husky USA Cable Tray & Cable Bus.
7. Niedax Inc.

B. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.



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2. Width: 24 inch unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 4 inch unless otherwise indicated on Drawings.
4. Straight Section Lengths: 12 ft., except where shorter lengths are required to facilitate tray assembly.
5. Rung Spacing: 9 inch on center.
6. Radius-Fitting Rung Spacing: 9 inch at center of tray's width.
7. Minimum Cable-Bearing Surface for Rungs: 7/8 inch width with radius edges.
8. No portion of the rungs must protrude below the bottom plane of side rails.
9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200 lb. concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: 36 inch.
11. Class Designation: Comply with NEMA VE 1, 12C.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splice-Plate Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.
14. Covers: As indicated on the Drawings made of same materials and with same finishes as cable tray.

C. Materials and Finishes:

1. Steel:
  - a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A1011/A1011M, SS, Grade 33.
  - b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
  - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
  - d. Finish:
    - 1) Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2, with stainless steel, Type 316 hardware.
2. Aluminum:
  - a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 according to ANSI H35.1/H 35.1M for fabricated parts.
  - b. Hardware: Stainless steel, Type 316, ASTM F593 and ASTM F594.
3. Stainless Steel:
  - a. Materials: Low-carbon, passivated stainless steel, Type 316L, ASTM F593 and ASTM F594.
  - b. Hardware for Stainless Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.



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2.3 SOLID-BOTTOM CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line; Eaton, Electrical Sector.
2. Chalfant Manufacturing Company.
3. Cope; Atkore International.
4. MonoSystems, Inc.
5. MP Husky USA Cable Tray & Cable Bus.
6. Niedax Inc.

B. Description:

1. Configuration: Two longitudinal side rails with a nonventilated continuous bottom.
2. Width: 24 inch unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 4 inch unless otherwise indicated on Drawings.
4. Straight Section Lengths: 12 ft., except where shorter lengths are required to facilitate tray assembly.
5. No portion of the continuous bottom must protrude below the bottom plane of side rails.
6. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200 lb. concentrated load, when tested according to NEMA VE 1.
7. Fitting Minimum Radius: 36 inch.
8. Class Designation: Comply with NEMA VE 1, 12B.
9. Splicing Assemblies: Bolted type using serrated flange locknuts.
10. Splice-Plate Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.
11. Covers: Solid type made of same materials and with same finishes as cable tray.

C. Materials and Finishes:

1. Steel:
  - a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A1011/A1011M, SS, Grade 33.
  - b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
  - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
  - d. Finish:
    - 1) Hot-dip galvanized after fabrication complying with ASTM A123/A123M, Class B2, with stainless steel, Type 316 hardware.
2. Aluminum:
  - a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 according to ANSI H35.1/H 35.1M for fabricated parts.



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- b. Hardware: Stainless steel, Type 316, ASTM F593 and ASTM F594.
- 3. Stainless Steel:
  - a. Materials: Low-carbon, passivated stainless steel, Type 316L, ASTM F593 and ASTM F594.
  - b. Hardware for Stainless Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

## 2.4 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

## 2.5 WARNING SIGNS

- A. Lettering: 1-1/2 inch high, black letters on yellow background, with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
- B. Comply with Section 26 05 53 "Identification for Electrical Systems."

## 2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

# PART 3 - EXECUTION

## 3.1 INSTALLATION OF CABLE TRAY

- A. Fasten cable tray supports to building structure and install seismic restraints.
- B. Design fasteners and supports to carry cable tray, cables, and a concentrated load of 200 lb. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- C. Place supports at ten (10) foot maximum intervals, so that spans do not exceed maximum spans on schedules, and provide clearances shown on Drawings. Install



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intermediate supports when cable weight exceeds the load-carrying capacity of tray rungs.

- D. Do not install more than one cable tray splice between supports.
- E. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- F. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed recommended dimensions. Space connectors and set gaps according to applicable standard.
- G. Make cable tray connections using manufacturer's recommended fittings.
- H. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- I. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- J. Install permanent covers and cover clamps, if used, after installing cable.
- K. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

### 3.2 CABLE TRAY GROUNDING

- A. Cable trays with electrical power conductors must be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- B. Cable trays with single-conductor power conductors must be bonded together with a minimum 1/0 AWG bare copper grounding conductor run in the tray along with the power conductors and bonded to each tray section using listed means. The grounding conductor must be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays." Bonding conductor shall connect to facility ground or building steel at each end and a maximum 100 foot intervals along the run.
- C. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

### 3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:



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1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items, such as pipes, hangers, or other equipment, in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

**END OF SECTION 26 05 36**



## **SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Duct accessories.
4. Precast concrete handholes.
5. Precast manholes.
6. Cast-in-place manholes.

#### **1.2 QUALITY ASSURANCE**

- A. Testing Agency Qualifications:** Qualified according to ASTM E329 for testing indicated.

### **PART 2 - PRODUCTS**

#### **2.1 METAL CONDUIT AND FITTINGS**

- A. GRC:** Comply with ANSI C80.1 and UL 6.

- B. Coated Steel Conduit:** PVC-coated GRC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

- C. Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Products Division.
2. AFC Cable Systems; Atkore International.
3. Allied Tube & Conduit; Atkore International.
4. Anaconda Sealtite; Anamet Electrical, Inc.
5. Calconduit; Atkore International.
6. Champion Fiberglass, Inc.
7. Electri-Flex Company.
8. FSR Inc.
9. Korkap.



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10. NEC, Inc.
11. NewBasis.
12. Opti-Com Manufacturing Network, Inc (OMNI).
13. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
14. Patriot Aluminum Products, LLC.
15. Perma-Cote; Robroy Industries.
16. Picoma; Zekelman Industries.
17. Plasti-Bond; Robroy Industries.
18. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
19. Southwire Company.
20. Topaz Lighting & Electric.
21. Western Tube; Zekelman Industries.
22. Wheatland Tube; Zekelman Industries.

- D. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

## 2.2 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- C. Solvents and Adhesives: As recommended by conduit manufacturer.
1. VOC Content: **510**g/L or less for PVC conduit and fittings.

## 2.3 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. ABB, Electrification Products Division.
  - b. Allied Tube & Conduit; Atkore International.
  - c. Cantex Inc.
  - d. IPEX USA LLC.
  - e. PenCell Plastics.
  - f. Underground Devices, Inc.
- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 26 05 53 "Identification for Electrical Systems."



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- C. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.
  - 1. Color: Red dye added to concrete during batching.
  - 2. Mark each plank with "ELECTRIC" in 2-inch- high, 3/8-inch- deep letters.

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Christy Concrete Products.
  - 2. Elmhurst-Chicago Stone Co.
  - 3. Oldcastle Infrastructure Inc.; CRH Americas.
  - 4. Rinker Group, Ltd.
  - 5. Riverton Concrete Products.
  - 6. Utility Concrete Products, LLC.
  - 7. Utility Vault Co.
  - 8. Wausau Tile Inc.
- C. Comply with ASTM C858 for design and manufacturing processes.
- D. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- E. Cover Legend: Molded lettering, as indicated for each service.
- F. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.
- G. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
  - 1. Extension shall provide increased depth of 12 inches.
  - 2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
- H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- I. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.



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1. Center window location.
  2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
  3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
  4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
  5. Knockout panels shall be 1-1/2 to 2 inches thick.
- J. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
1. Type and size shall match fittings to duct to be terminated.
  2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.
- K. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.5 PRECAST MANHOLES

- A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carder Concrete Products.
  2. Christy Concrete Products.
  3. Elmhurst-Chicago Stone Co.
  4. Oldcastle Infrastructure Inc.; CRH Americas.
  5. Rinker Group, Ltd.
  6. Riverton Concrete Products.
  7. Utility Concrete Products, LLC.
  8. Utility Vault Co.
  9. Wausau Tile Inc.
- C. Comply with ASTM C858.
- D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.
- E. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
1. Type and size shall match fittings to duct to be terminated.



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- 2. Fittings shall align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.
- F. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.
- G. Waterproofing: Provide waterproofing coating on full exterior of manhole prior to delivery.
- H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

## 2.6 CAST-IN-PLACE MANHOLES

- A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.
- B. Structural Design Loading: As specified in "Underground Enclosure Application" Article.
- C. Provide waterproofing coating on full exterior of manhole following form removal.

## 2.7 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C1037.

# PART 3 - EXECUTION

## 3.1 DUCT AND DUCT-BANK INSTALLATION

- A. End Bell Entrances to Manholes and Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes. Provide compression plugs to prevent moisture intrusion for all end bells.
  - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.
  - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
  - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- B. Concrete-Encased Ducts and Duct Bank:



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1. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
  - a. 12 kV duct banks shall have 3000 psi minimum strength and have red dye mixed into the entire batch.
  - b. Communications and security duct banks shall have 3000 psi minimum strength and have orange dye mixed into the entire batch.
  - c. Low voltage duct banks (600 volts and below) which are below parking or roadway areas shall be encased in non-colored concrete.
- C. Warning Planks: Bury warning planks approximately 12 inches above direct-buried duct, placing them 24 inches o.c. Align planks along the width and along the centerline of duct or duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.
- D. Underground-Line Warning Tape: Bury conducting underground line specified in Section 26 05 53 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

### 3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
  2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
  3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

**END OF SECTION 26 05 43**



## **SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Round sleeves.
2. Sleeve seal systems.
3. Grout.
4. Pourable sealants.
5. Foam sealants.

### **PART 2 - PRODUCTS**

#### **2.1 ROUND SLEEVES**

**A. Wall Sleeves, Steel:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Advance Products & Systems, LLC.
  - b. CCI Piping Systems.
  - c. Flexicraft Industries.
  - d. GPT; an EnPro Industries company.
2. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

**B. Wall Sleeves, Cast Iron:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Ductile Iron Pipe.
  - b. Flexicraft Industries.
  - c. McWane Ductile.
2. Description: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

**C. Pipe Sleeves, PVC sleeves may be prohibited by the Authority Having Jurisdiction:**



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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. CCI Piping Systems.
  - b. GPT; an EnPro Industries company.
  - c. Metraflex Company (The).
2. Description: ASTM D1785, Schedule 40.

D. Molded Sleeves, PVC may be prohibited by the Authority Having Jurisdiction :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Products Division.
  - b. Arlington Industries, Inc.
  - c. Reliance Worldwide Corporation.
2. Description: With nailing flange for attaching to wooden forms.

E. Molded Sleeves, PE or PP:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Crete-Sleeve.
2. Description: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sheet Metal Sleeves, Galvanized Steel, Round:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Benefast.
  - b. Specified Technologies, Inc.
2. Description: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

## 2.2 SLEEVE SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. BWM Company.
3. CALPICO, Inc.
4. Flexicraft Industries.



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5. Metraflex Company (The).
6. Pipeline Seal and Insulator, Inc.
7. Proco Products, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.

1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

## 2.3 GROUT

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. W.R. Meadows, Inc.

B. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Design Mix: 5000 psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

## 2.4 POURABLE SEALANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carlisle SynTec Incorporated.
2. GAF.
3. Johns Manville; a Berkshire Hathaway company.

B. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

C. Sustainability Criteria:

1. Verify sealant has a VOC content of 50 g/L or less.



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2.5 FOAM SEALANTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Dow Chemical Company (The).
  - 2. Innovative Chemical Products (Building Solutions Group).
- B. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.
- C. Sustainability Criteria:
  - 1. Verify sealant has a VOC content of 50 g/L or less.

**END OF SECTION 260544**



## **SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Elastomeric isolation pads.
2. Restraints - rigid type.
3. Restraints - cable type.
4. Restraint accessories.
5. Post-Installed concrete anchors.
6. Concrete inserts.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. Delegated Design:** Engage qualified structural professional engineer to design seismic and wind-load control system in accordance with criteria specified in Section 26 00 10 "Supplemental Requirements for Electrical" and Section 26 00 11 "Facility Performance Requirements for Electrical."
- B. Seismic- and Wind-Load-Restraint Device Load Ratings:** Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an evaluation service member of ICC-ES.
- C. Consequential Damage:** Provide additional seismic and wind-load restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.
- D. Fire/Smoke Resistance:** Seismic and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- E. Component Supports:**



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1. Load ratings, features, and applications of reinforcement components must be based on testing standards of a nationally recognized testing agency.

## 2.2 ELASTOMERIC ISOLATION PADS

### A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; nVent.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Novia; A Division of C&P.
  - i. Vibration Eliminator Co., Inc.
  - j. Vibration Isolation.
  - k. Vibration Management Corp.
  - l. Vibration Mountings & Controls, Inc.
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
5. Surface Pattern: Smooth, ribbed, or waffle pattern.

## 2.3 RESTRAINTS - RIGID TYPE

### A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line; Eaton, Electrical Sector.
2. CADDY; nVent.
3. California Dynamics Corporation.
4. Hilti, Inc.
5. Isolation Technology, Inc.
6. TOLCO.
7. Unistrut; Atkore International.
8. Vibration Mountings & Controls, Inc.

### B. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to



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building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.4 RESTRAINTS - CABLE TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. B-line; Eaton, Electrical Sector.
  2. CADDY; nVent.
  3. Loos & Co.
  4. Vibration Mountings & Controls, Inc.
- B. Seismic- and Wind-Load-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.
- C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

## 2.5 RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. B-line; Eaton, Electrical Sector.
  2. CADDY; nVent.
  3. Hilti, Inc.
  4. Loos & Co.
  5. Mason Industries, Inc.
  6. TOLCO.
  7. Unistrut; Atkore International.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.



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- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

## 2.6 POST-INSTALLED CONCRETE ANCHORS

### A. Mechanical Anchor Bolts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. B-line; Eaton, Electrical Sector.
  - b. Hilti, Inc.
  - c. Mason Industries, Inc.
  - d. Powers Fasteners.
  - e. Simpson Strong-Tie Co., Inc.
  - f. Unistrut; Atkore International.
- 2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

### B. Adhesive Anchor Bolts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. B-line; Eaton, Electrical Sector.
  - b. Hilti, Inc.
  - c. Mason Industries, Inc.
  - d. Powers Fasteners.
  - e. Simpson Strong-Tie Co., Inc.
  - f. Unistrut; Atkore International.
- 2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

### C. Provide post-installed concrete anchors that have been prequalified for use in seismic and wind-load applications.

- 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
- 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.



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- D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

1. Undercut expansion anchors are permitted.

## 2.7 CONCRETE INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line; Eaton, Electrical Sector.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Powers Fasteners.
5. Simpson Strong-Tie Co., Inc.
6. Unistrut; Atkore International.

- B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.

- C. Comply with MSS SP-58.

## PART 3 - EXECUTION

### 3.1 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by Architect .

- B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.

- C. Nonconforming Work:

1. Seismic controls will be considered defective if they do not pass tests and inspections.
2. Remove and replace malfunctioning units and retest as specified above.



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D. Prepare test and inspection reports.

**END OF SECTION 26 05 48**



## SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Materials:
  - a. Labels.
  - b. Bands and tubes.
  - c. Tapes and stencils.
  - d. Tags.
  - e. Signs.
  - f. Cable ties.
  - g. Miscellaneous identification products.
- 2. Identification for raceway and boxes.
- 3. Identification for conductors and communication and control cable.
- 4. Underground-line warning tape.
- 5. Warning labels and signs.
- 6. Instruction signs.
- 7. Equipment identification labels.

- B. Related Requirements

- 1. Section 26 05 13 "Medium-Voltage Cables".
- 2. Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables".
- 3. Section 26 05 23 "Control-Voltage Electrical Power Cables".
- 4. Section 26 05 33 "Raceway and Boxes for Electrical System".
- 5. Section 26 05 36 "Cable Trays for Electrical Systems".
- 6. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems".
- 7. Section 26 05 73.13 "Short Circuit Studies".
- 8. Section 26 05 73.19 "Arc-Flash Hazard Analysis".
- 9. Section 26 09 13 "Power Measurement and Control".
- 10. Section 26 09 14 "Power System Supervisory Control and Data Acquisition (SCADA)".
- 11. Section 26 11 16.12 "Secondary Unit Substations with Switchboard Secondary".
- 12. Section 26 13 26 "Medium-Voltage Metal-Clad Switchgear".



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13. Section 26 13 29 "Medium-Voltage Compartmentalized Switchgear".
14. Section 26 22 13 "Low-Voltage Distribution Transformers".
15. Section 26 24 13 "Switchboards".
16. Section 26 24 16 "Panelboards".
17. Section 26 28 16 "Enclosed Switches and Circuit Breakers".
18. Section 26 29 13.03 "Manual and Magnetic Motor Controllers".
19. Section 26 29 23 "Variable-Frequency Motor Controllers".
20. Section 26 32 13.13 "Diesel-Engine-Driven Generator Sets".
21. Section 26 33 53 "Static Uninterruptible Power Supply".
22. Section 26 36 00 "Transfer Switches".

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For Short Circuit and Arc-Flash Hazard studies.

### 1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, 29 CFR 1910.144 and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.



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## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with Section 26 05 73.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

### 2.2 RACEWAY AND BOXES











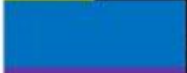

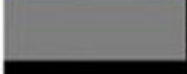


- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Color for Printed Legend:
  - 1. Power Circuits: Reference 2.3.G.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather - and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.
- E. Comply with the table on the following page for color coding raceways, unless indicated otherwise in Part 3 of this Section



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F. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER – HIGH VOLTAGE WIRING."

<u>COLOR CODE FOR ALL ELECTRICAL CONDUITS AT SDCRAA</u>		
	BROWN	HVAC
	YELLOW	277/480V
	YELLOW with white stripes	Lighting Control
	ORANGE	EMERGENCY/UPS
	ORANGE with blue stripes	Emergency 120/208V
	ORANGE with yellow stripes	Emergency 277/480V
	PINK	ACS/SECURITY
	RED	FIRE ALARM
	WHITE	TELEPHONE/DATA/DAS
	YELLOW/BLACK	12KV
	BLUE	120/208V
	PURPLE	LOADING BRIDGE
	GRAY	FIDS/RIDS/BIDS/VISUAL DISPLAY
	BLACK	PAGING/PA/Intercom
	GREEN	GROUND
RACEWAYS OVER 600V HAVE BLACK LETTERS IN AN ORANGE FIELD.		



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2.3 CONDUCTOR, COMMUNICATION AND CONTROL CABLE IDENTIFICATION

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Sleeves:
  - 1. Permanent PVC, yellow or white, with legible machine printed black markings.
- C. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
- D. Medium voltage cable tag: laminated Micarta type, 5" x 3½", nameplates engraved with 5/32-inch high black letters on white background for normal power and red letters on white background for emergency power.
- E. Provide tags on Mule Tape of spare conduits showing starting point and end point of spare conduits.
- F. Cables Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage.
- G. Coding for Phase-[ and Voltage-Level] Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors. :
  - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if Airport Authority permits.



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2. Colors:

System	Conductor	Color
All System	Equipment Grounding	Green
240/120 Volts, Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts, Three-Phase, Four-Wire, Delta, Center Tap, Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480/277 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow
12000Y/6930 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray 1-Stripe 2-Stripes 3-Stripes
Note: Phase A, B, C implies direction of positive phase rotation.		

3. Neutral or Phase Tracer: Outer covering of white or phase color with three continuous stripes, other than green for the entire length, in accordance with CEC.
4. Colors for Isolated Grounds: Green with two or more yellow stripes.

2.4 UNDERGROUND LINE WARNING TAPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Brady Corporation.
  2. Ideal Industries, Inc.
  3. LEM Products Inc.
  4. Marking Services, Inc.
  5. Seton Identification Products; a Brady Corporation company.
- B. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.



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- C. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
1. Not less than 6 inches wide by 4 mils thick. Color coded for electric lines (red) and for communication lines (orange).
  2. Warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be "CAUTION – BURIED ELECTRIC (or COMMUNICATION) LINE BELOW", or similar wording.
  3. Compounded for permanent direct-burial service. Code and lettering color shall be permanent, unaffected by moisture and other substances contained in trench backfill material.
  4. Embedded continuous metallic strip or core for detection from the surface.

## 2.5 WARNING LABELS AND SIGNS

- A. Comply with CEC, NEMA Z 535.4 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure- sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Metal-Backed, Butyrate Warning Signs: For all outdoor equipment. Weather- resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396- inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
- D. Warning labels and signs shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  2. Workspace Clearance Warning for maximum of 600 volts to ground and no grounded or energized parts on opposite side of the space: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR XX INCHES." Distances (XX) inserted shall be based upon clearance tables in CEC Article 110.
  3. High Voltage Equipment Warning, "DANGER – HIGH VOLTAGE – KEEP OUT".
  4. Arc-Flash Hazard Warning Labels (energy levels < 40 cal/cm<sup>2</sup>): "WARNING, ARC-FLASH HAZARD" plus the required information per Section 26 05 73.19 "Arc-Flash Hazard Analysis".
  5. Provide other warning labels and signs as required.

## 2.6 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.



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1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 EQUIPMENT IDENTIFICATION LABELS:

- A. Equipment Identification: Engraved laminated-plastic nameplate mounted with corrosion-resistant screws. Adhesive labels and nameplates are not acceptable.
- B. Labels shall include the following information in minimum 1/4 inch letters, except designation which will be in 3/8 inch letters. Color of nameplate shall be black for equipment connected to normal power, red for equipment connected to emergency power, and orange for equipment connected to Un- interruptible Power Supply. Color of letters shall be white.

1. Equipment Type.

Ex. TRANSFORMER, PANELBOARD, DISCONNECT,  
UNINTERRUPTED POWER SUPPLY, SWITCHBOARD...

2. Equipment Designation. (Made up of the following three components)

Abbreviated Regional Location: CT, T1E, T1W, SC, AF, CUP, FMD, etc.

Abbreviated Equipment Type: UPS, XFMR, PNL, DISC, etc.

Unique Equipment Identifier: T-ESCLW, TSA SERVER, SCLE3, XFMR T-LV1,  
etc.

Examples: FMD.DISC.XFMR T-LV1; FMD.PNL.P-HP1; SC.XFMR.T- ESCLW,  
etc.

3. Rating: Volt, Amps, No. of phase and wires, horsepower, etc.

Ex. 480V 3 PH, 480/277V 3 PH 4 WIRE-208/120V 3 PH 4 WIRE, 208V 3PH

Amperage, AIC Rating (RMS Symmetrical Amps) Fuse Size, Fuse Type.

Ex. 125 AMP 22kA-AIC, 30 KVA, 60 AMP FUSES, TD-R



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4. Fed from general information.

Ex. FED FROM PANELBOARD

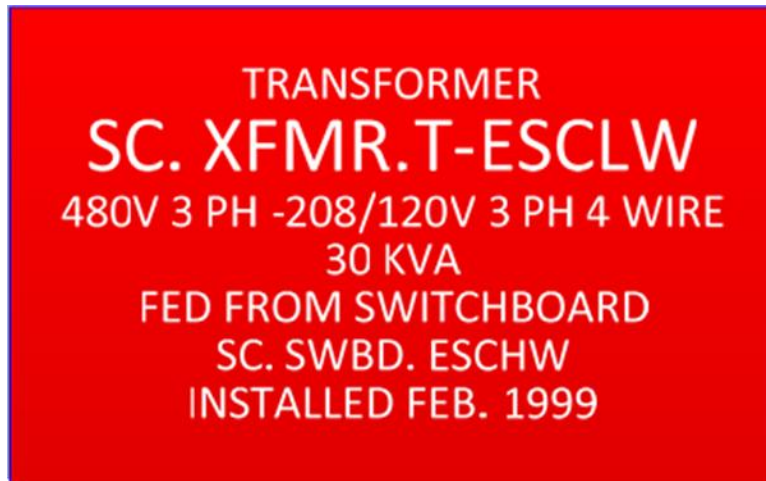
5. Fed from equipment designation.

Ex. SC.SWBD.ESCHW

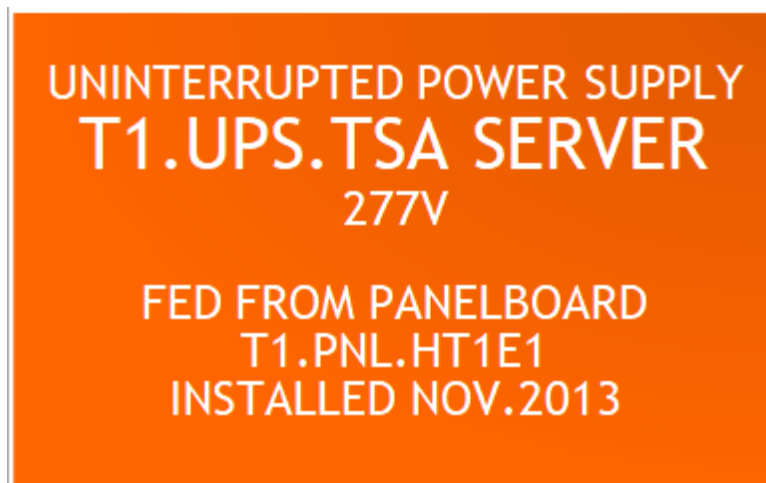
6. Date of Installation.

Ex. INSTALLED OCT-2015

7. Examples

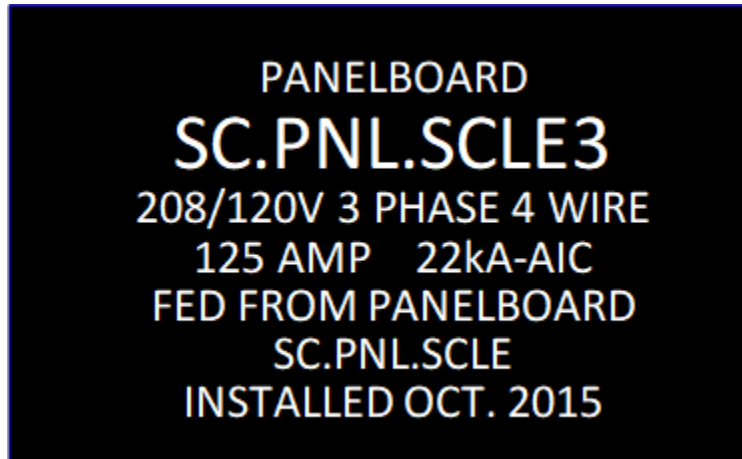


TRANSFORMER NAMEPLATE

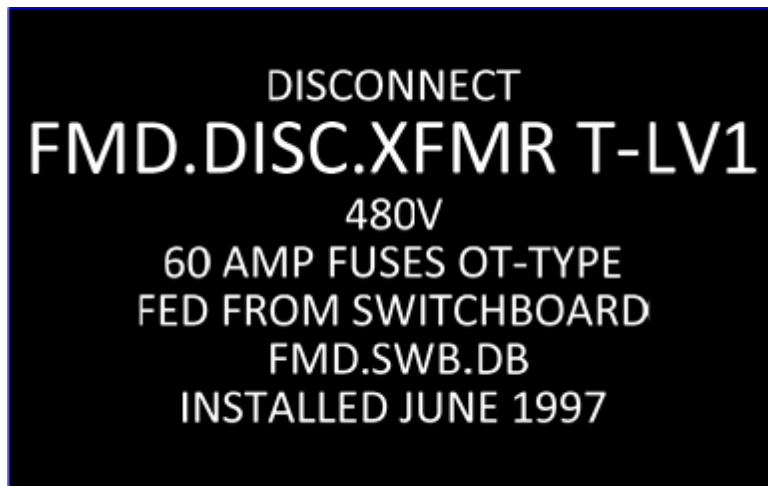




UPS NAMEPLATE



PANELBOARD NAMEPLATE



DISCONNECT NAMEPLATE

C. For medium-voltage switchgear:

1. Use 1 inch lettering to identify equipment designation
2. Use 3/4 inch lettering to identify voltage rating and source
3. Use 1/2 inch lettering to identify individual feeder breakers and compartments
4. Use 1/4 inch lettering to identify control switches, indicating lights, and other miscellaneous devices on the compartment door.



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2.8 WIRING DEVICES

- A. Identify wiring devices with clear vinyl polyester tape with black lettering, red lettering for emergency power. Labels shall be printed, flexible, self-adhesive type. For stainless steel cover plates, engrave information on cover plate.
- B. Receptacle and switch plate labels shall include panel designation and circuit number.
- C. For receptacles other than 20A, 120V, labels shall include receptacle voltage, phase and amperage at top of receptacle and panel designation and circuit numbers at bottom of receptacles.

2.9 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. HellermannTyton.
    - c. LEM Products Inc.
    - d. Marking Services, Inc.
    - e. Panduit Corp.
    - f. Seton Identification Products; a Brady Corporation company.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. HellermannTyton.
    - c. Marking Services, Inc.
    - d. Panduit Corp.
    - e. Seton Identification Products; a Brady Corporation company.



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- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Ideal Industries, Inc.
    - c. LEM Products Inc.
    - d. Marking Services, Inc.
    - e. Panduit Corp.
    - f. Seton Identification Products; a Brady Corporation company.
  2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
  3. Marker for Labels:
    - a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
    - b. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. HellermannTyton.
    - c. Ideal Industries, Inc.
    - d. LEM Products Inc.
    - e. Marking Services, Inc.
    - f. Panduit Corp.
    - g. Seton Identification Products; a Brady Corporation company.
  2. Minimum Nominal Size:
    - a. 1-1/2 by 6 inches for raceway and conductors.
    - b. As required by authorities having jurisdiction.

2.10 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.



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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. HellermannTyton.
  - c. Marking Services, Inc.
  - d. Panduit Corp.

- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Panduit Corp.

## 2.11 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carlton Industries, LP.
  - b. HellermannTyton.
  - c. Ideal Industries, Inc.
  - d. Marking Services, Inc.
  - e. Panduit Corp.

- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Carlton Industries, LP.
  - c. Marking Services, Inc.

- C. Tape and Stencil: 4-inch- wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.



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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. HellermannTyton.
  - b. LEM Products Inc.
  - c. Marking Services, Inc.
  - d. Seton Identification Products; a Brady Corporation company.

D. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carlton Industries, LP.
  - b. Seton Identification Products; a Brady Corporation company.

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 2 inch.

## 2.12 TAGS

A. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Carlton Industries, LP.
  - c. Marking Services, Inc.
  - d. Panduit Corp.
  - e. Seton Identification Products; a Brady Corporation company.

B. Write-on Tags:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carlton Industries, LP.
  - b. LEM Products Inc.
  - c. Seton Identification Products; a Brady Corporation company.

2. See 2.3.C for construction requirements.



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2.13 SIGNS

A. Baked-Enamel Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carlton Industries, LP.
  - b. Champion America.
  - c. Marking Services, Inc.
2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
3. 1/4-inch grommets in corners for mounting.
4. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Marking Services, Inc.
2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396 inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
3. 1/4-inch grommets in corners for mounting.
4. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Carlton Industries, LP.
  - c. Marking Services, Inc.
2. Engraved legend.
3. Thickness:
  - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
  - b. For signs larger than 20 sq. in., 1/8 inch thick.
  - c. Engraved legend with black letters on white face.
  - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
  - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.



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2.14 CABLE TIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. HellermannTyton.
  2. Ideal Industries, Inc.
  3. Marking Services, Inc.
  4. Panduit Corp.
- B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black, except where used for color-coding.
- C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black except where used for color-coding.
- D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.
  3. UL 94 Flame Rating: 94V-0.
  4. Temperature Range: Minus 50 to plus 284 deg F.
  5. Color: Black except where used for color-coding.

2.15 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.



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PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Verify identity of each item before installing identification products.
- E. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- F. Apply identification devices to surfaces that require finish after completing finish work.
- G. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- H. System Identification color banding for Raceways and Cables : Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs and at 25-foot maximum intervals in congested areas.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer or load shedding.



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- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
  - 3. "UPS."
- M. Vinyl Wraparound Labels:
  - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
  - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Wraparound Labels: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device. Use only where permitted. Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Labels:
  - 1. Clean surfaces before application, using materials and methods recommended by manufacturer of identification device. Use only where permitted.
  - 2. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  - 3. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
- Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
  - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.



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- U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- W. Underground Line Warning Tape:
  - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
  - 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- X. Nonmetallic Preprinted Tags:
  - 1. Place in a location with high visibility and accessibility.
  - 2. Secure using UV-stabilized or plenum-rated cable ties.
- Y. Write-on Tags:
  - 1. Place in a location with high visibility and accessibility.
  - 2. Secure using UV-stabilized or plenum-rated cable ties.
- Z. Baked-Enamel Signs:
  - 1. Attach signs with mechanical fasteners appropriate to the location and substrate.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on minimum 1-1/2-inch- high sign; where two lines of text are required, use signs minimum 2 inches high.
- AA. Metal-Backed Butyrate Signs:
  - 1. Attach signs with mechanical fasteners appropriate to the location and substrate.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.
- BB. Laminated Acrylic or Melamine Plastic Signs:
  - 1. Attach signs with mechanical fasteners appropriate to the location and substrate.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.
- CC. Cable Ties: General purpose, for attaching tags, except as listed below:
  - 1. Outdoors: UV-stabilized nylon.



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2. In Spaces Handling Environmental Air: Plenum rated.

### 3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch- high, black letters on 20-inch centers.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10-foot maximum intervals.
- D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Identify with orange Self-adhesive vinyl labels.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 50 A: Identify with orange self-adhesive vinyl label showing voltage.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
  - 3. "UPS."
- G. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in indoor pull and junction boxes, use color coding conductor tape and marker tape unless otherwise noted. Ref. 2.3 B in this Section. Every conductor shall be identified in every junction box. Every junction box shall have the circuit info on the interior and on the cover.



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- H. For conductors in underground vaults, manholes, and handholes Ref. 2.3 D, this section. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- J. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.
- K. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.
- L. Auxiliary Electrical Systems Conductor Identification: Marker tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  - 2. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- M. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- N. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
  - 1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
  - 2. Wall surfaces directly external to raceways concealed within wall.
  - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- O. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- P. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- Q. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
  - 1. Apply to exterior of door, cover, or other access.
  - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
    - a. Power-transfer switches.



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- b. Controls with external control power connections.
- R. Arc Flash Warning Labeling: Self-adhesive labels.
- S. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.
  - 1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- T. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer and load shedding.
- U. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer and load shedding.
- V. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems.
  - 1. Labeling Instructions:
    - a. Equipment: Engraved, laminated plastic, screwed on type. Unless otherwise indicated, provide a single line of text 1-1/2- inch- high label; where 2 lines of text are required, use labels 2 inches high. Nameplates for switchboards, transformers, MCC, panel boards shall be minimum of 2-inch high by 4-inch wide.
    - b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
  - 2. Equipment to Be Labeled:
    - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer.
    - b. Enclosures and electrical cabinets.
    - c. Access doors and panels for concealed electrical items.
    - d. Switchgear.
    - e. Switchboards.
    - f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    - g. Substations.
    - h. Emergency system boxes and enclosures.
    - i. Motor-control centers.
    - j. Enclosed switches.



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- k. Enclosed circuit breakers.
- l. Enclosed controllers.
- m. Variable-speed controllers.
- n. Push-button stations.
- o. Power-transfer equipment.
- p. Contactors.
- q. Remote-controlled switches, dimmer modules, and control devices.
- r. Battery-inverter units.
- s. Battery racks.
- t. Power-generating units.
- u. Monitoring and control equipment.
- v. UPS equipment.
- w. Voice and data cable terminal equipment.
- x. Master clock and program equipment.
- y. intercommunication and call system master and staff stations.
- z. Television/audio components, racks and controls.
- aa. Fire Alarm control panel and annunciators
- bb. Security and intrusion-detection control stations, control panels, terminal cabinets and racks.
- cc. Terminals, racks and patch panels for voice and data communication and for signal and control functions.

**END OF SECTION 26 05 53**



## **SECTION 26 05 73.13 - SHORT-CIRCUIT STUDIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

#### **1.3 DEFINITIONS**

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.
- B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state of California.
- F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- G. SCCR: Short-circuit current rating.
- H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- I. Single-Line Diagram: See "One-Line Diagram."



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1.4 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals may be in digital form (PDF).
  - a. Short-circuit study input data, including completed computer program input data sheets.
    - 1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
    - 2) Submit final study report following power system installation but prior to energization, confirming equipment is adequately rated for the available short circuit conditions.
    - 3) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Software Developer.
2. For Power System Analysis Specialist.
3. For Field Adjusting Agency.

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
2. The following are from the Short-Circuit Study Report:
  - a. Final one-line diagram.
  - b. Final Short-Circuit Study Report.
  - c. Short-circuit study data files in Power Systems Analysis Software native format, including all library data for model components.
  - d. Power system data.

B. Labels for field application at all service entrance equipment identifying the available short circuit current.



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1.7 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
  - 1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
  - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state of California. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- F. Field Adjusting Agency Qualifications:
  - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
  - 2. A member company of NETA.
  - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. SKM Systems Analysis, Inc.
  - 2. CGI CYME.
  - 3. EasyPower, LLC (formerly ESA Inc.).
  - 4. EDSA Micro Corporation.
  - 5. Operation Technology, Inc.
  - 6. Power Analytics, Corporation.



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- B. Comply with IEEE 399 and IEEE 551.
  - 1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

## 2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
  - 1. Protective device designations and ampere ratings.
  - 2. Conductor types, sizes, and lengths.
  - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
  - 4. Motor and generator designations and kVA ratings.
  - 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
  - 6. Derating factors and environmental conditions.
  - 7. Any revisions to electrical equipment required by the study.
- D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.
- E. Protective Device Evaluation:
  - 1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
  - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
  - 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
  - 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
  - 5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.



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F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
  - a. Voltage.
  - b. Calculated fault-current magnitude and angle.
  - c. Fault-point X/R ratio.
  - d. Equivalent impedance.
2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
  - a. Voltage.
  - b. Calculated symmetrical fault-current magnitude and angle.
  - c. Fault-point X/R ratio.
  - d. Calculated asymmetrical fault currents:
    - 1) Based on fault-point X/R ratio.
    - 2) Based on calculated symmetrical value multiplied by 1.6.
    - 3) Based on calculated symmetrical value multiplied by 2.7.
3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
  - a. Voltage.
  - b. Calculated symmetrical fault-current magnitude and angle.
  - c. Fault-point X/R ratio.
  - d. No AC Decrement (NACD) ratio.
  - e. Equivalent impedance.
  - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
  - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

## PART 3 - EXECUTION

### 3.1 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the study.
1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.



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2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 01 78 39 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
11. Derating factors.

### 3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Begin short-circuit current analysis at the Substation Vault Main Service Switchgear, extending down to system overcurrent protective devices as follows:



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1. To normal system low-voltage load buses where fault current is 10 kA or less.
  2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.
- E. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- F. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.
- G. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- H. Include in the report identification of any protective device applied outside its capacity.

### 3.3 LABELING

- A. Apply label indicating available short circuit current, the date calculated and the identity of the party performing the calculation at all service entrance electrical equipment in compliance with NEC Article 110.24.

**END OF SECTION 26 05 73.13**



## **SECTION 26 05 73.16 - COORDINATION STUDIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

#### **1.3 DEFINITIONS**

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.
- B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- E. Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state of California.
- F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- G. SCCR: Short-circuit current rating.
- H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.



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- I. Single-Line Diagram: See "One-Line Diagram."

#### 1.4 ACTION SUBMITTALS

##### A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals may be in digital form (PDF).
  - a. Coordination-study input data, including completed computer program input data sheets.
  - b. Study and equipment evaluation reports.
3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
  - a. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory. Study shall demonstrate that protective devices shall Selectively Coordinate for Life Safety, Legally Required Standby, Healthcare Essential Power System, and common elevator driving machine feeder power circuits as required by the NEC.
  - b. Submit final study report following power system installation but prior to energization, confirming power system overcurrent device coordination or Selective Coordination, as required by the NEC, has been achieved.

#### 1.5 INFORMATIONAL SUBMITTALS

##### A. Qualification Data:

1. For Power System Analysis Software Developer.
2. For Power Systems Analysis Specialist.
3. For Field Adjusting Agency.

- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

#### 1.6 CLOSEOUT SUBMITTALS

- ##### A. Operation and Maintenance Data: For overcurrent protective devices to include in emergency, operation, and maintenance manuals.

1. The following are from the Coordination Study Report:
  - a. Final one-line diagram.
  - b. Final protective device coordination study.



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- c. Coordination study data files in Power Systems Analysis Software native format, including all library data for modeled components.
- d. List of all protective device settings.
- e. Time-current coordination curves.
- f. Power system data.

## 1.7 QUALITY ASSURANCE

- A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications:
  - 1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.
  - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state of California. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Field Adjusting Agency Qualifications:
  - 1. Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.
  - 2. A member company of NETA.
  - 3. Acceptable to authorities having jurisdiction.

## PART 2 - PRODUCTS

### 2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. SKM Systems Analysis, Inc.
  - 2. CGI CYME.
  - 3. EasyPower, LLC (formerly ESA Inc.).



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4. EDSA Micro Corporation.
5. Operation Technology, Inc.
6. Power Analytics, Corporation.

- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
1. Optional Features:
    - a. Arcing faults.

## 2.2 COORDINATION STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
1. Protective device designations and ampere ratings.
  2. Conductor types, sizes, and lengths.
  3. Transformer kilovolt ampere (kVA) and voltage ratings.
  4. Motor and generator designations and kVA ratings.
  5. Switchgear, switchboard, motor-control center, and panelboard designations.
  6. Any revisions to electrical equipment required by the study.
  7. Study Input Data: As described in "Power System Data" Article.
- D. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73.13 "Short-Circuit Studies."
- E. Protective Device Coordination Study:
1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
    - a. Phase and Ground Relays:
      - 1) Device tag.
      - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.



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- 3) Recommendations on improved relaying systems, if applicable.
  - b. Circuit Breakers:
    - 1) Adjustable pickups and time delays (long time, short time, and ground).
    - 2) Adjustable time-current characteristic.
    - 3) Adjustable instantaneous pickup.
    - 4) Recommendations on improved trip systems, if applicable.
  - c. Fuses: Show current rating, voltage, and class.
- F. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve coordination or Selective Coordination, as required by the NEC. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
  - 1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
  - 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
  - 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
  - 4. Plot the following listed characteristic curves, as applicable:
    - a. Power utility's overcurrent protective device.
    - b. Medium-voltage equipment overcurrent relays.
    - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
    - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
    - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
    - f. Cables and conductors damage curves.
    - g. Ground-fault protective devices.
    - h. Motor-starting characteristics and motor damage points.
    - i. Generator short-circuit decrement curve and generator damage point.
    - j. The largest feeder circuit breaker in each switchboard, motor-control center and panelboard.
  - 5. Maintain selectivity for tripping currents caused by overloads.
  - 6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
  - 7. Provide adequate time margins between device characteristics such that selective operation is achieved.
  - 8. Comments and recommendations for system improvements.



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PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
  - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in Final Study, Preliminary Study shall use proposed devices to demonstrate the ability to provide the required coordination conditions prior to being approved for use.

3.2 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the overcurrent protective device study.
  - 1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
  - 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
  - 3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.
- B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
  - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
  - 2. Electrical power utility impedance at the service.
  - 3. Power sources and ties.
  - 4. Short-circuit current at each system bus (three phase and line to ground).
  - 5. Full-load current of all loads.
  - 6. Voltage level at each bus.
  - 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.



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8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Maximum demands from service meters.
13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
14. Motor horsepower and NEMA MG 1 code letter designation.
15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
16. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
17. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:
  - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
  - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
  - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
  - d. Generator thermal-damage curve.
  - e. Ratings, types, and settings of utility company's overcurrent protective devices.
  - f. Special overcurrent protective device settings or types stipulated by utility company.
  - g. Time-current-characteristic curves of devices indicated to be coordinated.
  - h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
  - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
  - j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.

### 3.3 COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.



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- B. Comply with IEEE 399 for general study procedures.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Begin analysis at the Substation Vault Main Service Switchgear, extending down to system overcurrent protective devices as follows:
  - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
  - 2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.
- E. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- F. Transformer Primary Overcurrent Protective Devices:
  - 1. Device shall not operate in response to the following:
    - a. Inrush current when first energized.
    - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
  - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- G. Motor Protection:
  - 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
  - 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- H. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- I. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.
- J. For Life Safety, Legally Required Standby, Healthcare Essential Power and common elevator driving machinery circuit systems demonstrate the achievement of Selective Coordination as required by the NEC.



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3.4 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
- C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.5 DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in the following:
  - 1. Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.
  - 2. Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.
  - 3. For Owner's maintenance staff certified as NETA ETT-Certified Technicians Level III or NICET Electrical Power Testing Level III Technicians, teach how to adjust, operate, and maintain overcurrent protective device settings.

**END OF SECTION 26 05 73.16**



## **SECTION 26 05 73.19 - ARC-FLASH HAZARD ANALYSIS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work involving examination, adjustment, servicing or maintenance on or near energized electrical equipment where enclosures must be opened or personnel are exposed to energized conductors.

#### **1.3 DEFINITIONS**

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state of California.
- F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- G. SCCR: Short-circuit current rating.



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- H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- I. Single-Line Diagram: See "One-Line Diagram."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals may be in digital form (PDF):
  - 1. Arc-flash study input data, including completed computer program input data sheets.
  - 2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
    - a. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
    - b. Submit final study report following power system installation but prior to energization, confirming arc flash hazard of the as-installed condition.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
  - 1. For Power Systems Analysis Software Developer.
  - 2. For Power System Analysis Specialist.
  - 3. For Field Adjusting Agency.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
  - 1. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
  - 2. Operation and Maintenance Procedures: In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.



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- 3. Arc Flash Hazard Study data files in Power System Analysis Software native format, including all library data for modeled components.
- B. Arc Flash Hazard warning labels for installation on the study evaluated equipment enclosures.

1.7 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  - 1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
  - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state of California. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. Field Adjusting Agency Qualifications:
  - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
  - 2. A member company of NETA.
  - 3. Acceptable to authorities having jurisdiction.



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PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. SKM Systems Analysis, Inc.
  2. CGI CYME.
  3. EasyPower, LLC (formerly ESA Inc.).
  4. EDSA Micro Corporation.
  5. Operation Technology, Inc.
  6. Power Analytics, Corporation.
- B. Comply with IEEE 1584 and NFPA 70E.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
1. Protective device designations and ampere ratings.
  2. Conductor types, sizes, and lengths.
  3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
  4. Motor and generator designations and kVA ratings.
  5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73.13 "Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 26 05 73.16 "Coordination Studies."
- G. Arc-Flash Study Output Reports:



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1. Interrupting Duty Report from Short Circuit Study: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
  - a. Voltage.
  - b. Calculated symmetrical fault-current magnitude and angle.
  - c. Fault-point X/R ratio.
  - d. No AC Decrement (NACD) ratio.
  - e. Equivalent impedance.
  - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
  - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

## 2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
- B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis. If the arc flash energy level is above 40 cal/cm<sup>2</sup>, header to be red with the wording "DANGER" and the label shall also indicate "NO ENERGIZED WORK".
  1. Location designation.
  2. Nominal voltage.
  3. Protection boundaries.
    - a. Arc-flash boundary.
    - b. Restricted approach boundary.
    - c. Limited approach boundary.
  4. Arc flash PPE category.



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5. Required minimum arc rating of PPE in Cal/cm squared.
  6. Available incident energy.
  7. Working distance.
  8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed on materials suitable for the environment where the equipment is installed and expected to provide a minimum of 5-year service life, with no field-applied markings.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

#### 3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis.
1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73.13 "Short-Circuit Studies."
  2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 26 05 73.16 "Coordination Studies."
- C. Calculate maximum and minimum contributions of fault-current size.
1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
  2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
- D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.
- F. Calculate the limited, restricted, and prohibited approach boundaries for each location.



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- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
  - 1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
  - 2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:
  - 1. When the circuit breaker is in a separate enclosure.
  - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

### 3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the arc-flash hazard analysis.
  - 1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Engineer's attention.
  - 2. For new equipment, use characteristics from proposed equipment in the Preliminary Study and approved submittals under provisions of action submittals and information submittals for this Project for the Final Study.
  - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
  - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment



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designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Obtain electrical power utility impedance or available short circuit current characteristics, including X/R ratio, at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactances and time constants, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

### 3.4 LABELING

- A. Apply one arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location. If Arc Fault Reduction systems are present, include information labels clearly identifying the reduced hazard level when the system is enabled.
- B. Each piece of equipment listed below shall have an arc-flash label applied to it:
  1. Motor-control center.
  2. Low-voltage switchboard.
  3. Medium-voltage and Low-Voltage switchgear.
  4. Medium-voltage switch.
  5. Medium voltage transformers
  6. Low voltage transformers.
  7. Panelboard and safety switch over 250 V.
  8. Applicable panelboard and safety switch under 250 V.



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9. Control panel.
10. Individually mounted enclosed circuit breakers.
11. Variable frequency drives.
12. Individually mounted enclosed motor controllers.
13. Automatic and Manual transfer switches.
14. Medium-Voltage Automatic Throw-over (ATO) switchgear.

3.5 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.6 DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

**END OF SECTION 26 05 73.19**



## SECTION 26 22 13 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB, Electrification Products Division.
  - 2. Eaton.
  - 3. Hammond Power Solutions Inc.
  - 4. Prolec GE; A Xignux and General Electric Company Joint Venture.
  - 5. Sola/Hevi-Duty; Emerson Electric Co.
  - 6. Square D; Schneider Electric USA.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to Section 01 46 00 "Seismic Design Requirements for Nonstructural Systems".
  - 1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified and transformers on the Essential Power System will be fully operational after the seismic event."



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2.3 GENERAL TRANSFORMER REQUIREMENTS

- A. Transformers Rated 15 kVA and Larger:
  - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
  - 2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.
- B. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.4 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 01 46 00 "Seismic Design Requirements for Nonstructural Systems"
- C. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
  - 1. One leg per phase.
  - 2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
  - 3. Grounded to enclosure.
- D. Coils: Continuous windings[ without splices] except for taps.
  - 1. Coil Material: Aluminum or Copper.
  - 2. Internal Coil Connections: Brazed or pressure type.
  - 3. Terminal Connections: Welded or Bolted.
- E. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- F. Enclosure for Indoor Units: Ventilated.
  - 1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.
  - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
  - 3. Wiring Compartment: Sized for conduit entry and wiring installation.
  - 4. Finish: Comply with NEMA 250.
    - a. Finish Color: Gray weather-resistant enamel.
  - 5. Provide infrared inspection windows rated for the available short circuit current to facilitate inspecting connections without removing covers.



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- G. Enclosure for Outdoor Units: Ventilated.
1. NEMA 250, Type 4X, Stainless Steel: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.
  2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
  3. Wiring Compartment: Sized for conduit entry and wiring installation.
  4. Provide infrared inspection windows rated for the available short circuit current to facilitate inspecting connections without removing covers.
- H. Taps for Transformers 3 kVA and Smaller: [None].
- I. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- J. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- K. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- L. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 80 deg C rise above 40 deg C ambient temperature.
- M. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- N. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
  2. Indicate value of K-factor on transformer nameplate.
  3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.
- O. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
  2. Include special terminal for grounding the shield.
- P. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.



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- Q. Wall Brackets: Wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.
- R. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
1. 9.00 kVA and Less: 40 dBA.
  2. 9.01 to 30.00 kVA: 45 dBA.
  3. 30.01 to 50.00 kVA: 45 dBA for K-factors of 1, 4, and 9.
  4. 50.01 to 150.00 kVA: 50 dBA for K-factors of 1, 4, and 9.
  5. 150.01 to 300.00 kVA: 55 dBA for K-factors of 1, 4, and 9.
  6. 300.01 to 500.00 kVA: 60 dBA for K-factors of 1, 4, and 9.
  7. 500.01 to 700.00: 62 dBA for K-factors of 1, 4, and 9.
  8. 700.01 to 1000.00: 64 dBA for K-factors of 1, 4, and 9.

## 2.5 IDENTIFICATION

- A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

## 2.6 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
  2. Ratio tests at rated voltage connections and at all tap connections.
  3. Phase relation and polarity tests at rated voltage connections.
  4. No load losses, and excitation current and rated voltage at rated voltage connections.
  5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
  6. Applied and induced tensile tests.
  7. Regulation and efficiency at rated load and voltage.
  8. Insulation-Resistance Tests:
    - a. High-voltage to ground.
    - b. Low-voltage to ground.
    - c. High-voltage to low-voltage.
  9. Temperature tests.



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PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.
  - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
  - 2. Brace wall-mounted transformers as specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
  - 1. Visual and Mechanical Inspection.
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, and grounding.
    - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
    - d. Verify the unit is clean.
    - e. Perform specific inspections and mechanical tests recommended by manufacturer.
    - f. Verify that as-left tap connections are as specified.
    - g. Verify the presence of surge arresters and that their ratings are as specified.
  - 2. Electrical Tests:
    - a. Measure resistance at each winding, tap, and bolted connection.



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- b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
  - c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
  - d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- F. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:
  - 1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, and grounding.
    - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
    - d. Verify the unit is clean.
    - e. Perform specific inspections and mechanical tests recommended by manufacturer.
    - f. Verify that as-left tap connections are as specified.
    - g. Verify the presence of surge arresters and that their ratings are as specified.
  - 2. Electrical Tests:
    - a. Measure resistance at each winding, tap, and bolted connection.
    - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
    - c. Perform power-factor or dissipation-factor tests on all windings.
    - d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
    - e. Perform an excitation-current test on each phase.
    - f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
    - g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- G. Remove and replace units that do not pass tests or inspections and retest as specified above.
- H. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.



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1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

3.3 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

**END OF SECTION 26 22 13**



## SECTION 26 24 13 - SWITCHBOARDS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.
8. Mimic bus.

#### 1.2 START-UP, COMMISSIONING AND MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to Section 01 46 00 "Seismic Design Requirements for Nonstructural Systems".



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1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
2. Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
3. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the units connected to the Essential Power System will be fully operational after the seismic event."

## 2.2 SWITCHBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. ABB, Electrification Products Division.
  2. Eaton.
  3. General Electric, an ABB Company
  4. Square D; Schneider Electric USA.
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Front-Connected, Front-Accessible Switchboards:
  1. Main Devices: Fixed, individually mounted.
  2. Branch Devices: Panel mounted.
  3. Sections front and rear aligned.
- D. Front- and Side-Accessible Switchboards:
  1. Main Devices: Fixed, individually mounted.
  2. Branch Devices: Panel mounted.
  3. Section Alignment: Front and Rear aligned.
- E. Front- and Rear-Accessible Switchboards:
  1. Main Devices: Fixed, individually mounted.
  2. Branch Devices: Fixed, individually mounted.
  3. Sections front and rear aligned.
- F. Nominal System Voltage: 480Y/277 V.
- G. Main-Bus Continuous: As indicated on the Drawings.



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- H. Indoor Enclosures: Steel, NEMA 250, Type 1. Include infrared viewing windows to allow inspection of bus and power circuit wiring connections without opening switchboard covers.
- I. Outdoor Enclosures: Type 3R.
  - 1. Enclosure: Flat roof; bolt-on rear covers except rear hinged doors for front and rear access assemblies for each section, with provisions for padlocking. Include infrared viewing windows to allow inspection of bus and power circuit wiring connections without opening switchboard covers.
  - 2. Doors: Personnel door at each section, minimum width of 30 inches; opening outwards; with provisions for padlocking. At least one door in each section shall be sized to permit the largest single switchboard section to pass through without disassembling doors, hinges, or switchboard section.
  - 3. Non-walk-in Heating and Ventilating:
    - a. See Space Heaters Paragraph below.
    - b. Ventilating openings shall be configured to preclude entry of insects or vermin and be complete with replaceable fiberglass air filters.
  - 4. Power for space heaters, ventilation, lighting, and receptacle provided by a remote source operating at 120/208 V.
- J. Barriers: Between adjacent switchboard sections.
- K. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- L. Space Heaters (Outdoor Units Only): Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
  - 1. Heater elements shall be applied at no more than one-half of rated voltage and include shields to preclude accidental contact by personnel.
  - 2. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
  - 3. Space-Heater Power Source: 120-V external branch circuit.
- M. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.
- N. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.



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- O. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- P. Removable, Hinged Rear Doors and Compartment Covers: Secured by stainless steel security bolts, for access to rear interior of switchboard.
- Q. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- R. Buses and Connections: Three phase, four wire unless otherwise indicated.
  - 1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
  - 2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated.
  - 3. Copper feeder circuit-breaker line connections.
  - 4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
  - 5. Ground Bus: 1/4-by-2-inch- hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
  - 6. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
  - 7. Disconnect Links:
    - a. Isolate neutral bus from incoming neutral conductors.
    - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
  - 8. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
  - 9. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- S. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- T. Bus-Bar Insulation: Factory-applied, flame-retardant, heat shrink applied tube of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.
- U. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.



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2.3 SURGE PROTECTION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. ABB, Electrification Products Division.
  2. Advanced Protection Technologies Inc. (APT).
  3. Eaton.
  4. General Electric, an ABB Company
  5. Square D; Schneider Electric USA.
- C. SPDs: Comply with UL 1449, Type 2.
- D. Features and Accessories:
1. Integral disconnect switch with 200 kAIC fuses.
  2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  3. Indicator light display for protection status.
  4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
  5. Surge counter with six (6) digit registration.
- E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 250kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- F. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V.
  2. Line to Ground: 1200 V for 480Y/277 V.
  3. Line to Line: 2000 V for 480Y/277 V.
- G. SCCR: Equal or exceed 100 kA.
- H. Nominal Rating: 20 kA.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Device types shown below (B through C),



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- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Maximum of 1200 amp frame size.
  2. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  3. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  4. Electronic trip circuit breakers 400 amp frame size and larger or as required by the overcurrent protective device coordination study, with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    - a.
    - b. Instantaneous trip.
    - c. Long- and short-time pickup levels.
    - d. Long and short time adjustments.
    - e. Ground-fault pickup level, time delay, and  $I^2t$  response.
  5. MCCB Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
    - c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- C. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
  2. Two-step, stored-energy closing.
  3. Standard -function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Time adjustments for long- and short-time pickup.
    - c. Ground-fault pickup level, time delay, and  $I^2t$  response.
  4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

## 2.5 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, and the following:
1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.



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2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; bar or window type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
  3. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
    - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
    - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
    - d. Megawatts: Plus or minus 1 percent.
    - e. Megavars: Plus or minus 1 percent.
    - f. Power Factor: Plus or minus 1 percent.
    - g. Frequency: Plus or minus 0.1 percent.
    - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
    - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
    - j. Contact devices to operate remote impulse-totalizing demand meter.
  2. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.
  3. Include provisions for recordable attachments.
- C. Test Switches:
1. If meters do not have integral facilities for isolation from instrument transformers, provide FT-1 style test switches to allow for device testing without requiring removal of circuit wiring.

## 2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation. Provide one set per Electrical Room or area having switchboards.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
- C. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.



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2.7 IDENTIFICATION

- A. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.
- B. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.
- C. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.
- D. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 IDENTIFICATION

- A. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter, test switch and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections
- E. Tests and Inspections:
  - 1. Acceptance Testing:



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- a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
  - b. Test continuity of each circuit.
2. Insulated-Case/Molded-Case Air-Circuit-Breaker Field Tests:
- a. Visual and Mechanical Inspection:
    - 1) Inspect physical and mechanical condition.
    - 2) Inspect anchorage and alignment.
    - 3) Verify the unit is clean.
    - 4) Operate the circuit breaker to ensure smooth operation.
    - 5) Inspect operating mechanism, contacts, and arc chutes in unsealed units.
  - b. Electrical Tests:
    - 1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    - 2) Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations must be investigated.
    - 3) Perform a contact/pole-resistance test. Microhm or dc millivolt drop values must not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
    - 4) Determine long-time pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current tolerance band, including adjustment factors.
    - 5) Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current tolerance band.
    - 6) Determine ground-fault pickup and time delay by primary current injection. Ground-fault pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current tolerance band.
    - 7) Determine instantaneous pickup by primary current injection. Instantaneous pickup values must be as specified and within



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- manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
- 8) Test functions of the trip unit on spare breakers by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.
  - 9) Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils must conform to the manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
  - 10) Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, anti-pump function, and trip unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in accordance with manufacturer's published data.
  - 11) Verify operation of charging mechanism. The charging mechanism must operate in accordance with manufacturer's published data.
3. Low-Voltage Ground-Fault Protection System Field Tests:
- a. Visual and Mechanical Inspection:
    - 1) Inspect the components for damage and errors in polarity or conductor routing.
    - 2) Verify that ground connection is made on the source side of the neutral disconnect link and on the source side of ground-fault sensor.
    - 3) Verify that the neutral sensors are connected with correct polarity on both primary and secondary.
    - 4) Verify that phase conductors and the neutral pass through the sensor in the same direction for zero sequence systems.
    - 5) Verify that grounding conductors do not pass through zero sequence sensors.
    - 6) Verify that grounded conductor is solidly grounded.
    - 7) Verify the unit is clean.
    - 8) Operate the circuit breaker to ensure smooth operation.
    - 9) Verify correct operation of functions of the self-test panel if provided.
    - 10) Verify that the control power transformer has adequate capacity for the system.
  - b. Electrical Tests:
    - 1) Measure the system neutral-to-ground insulation resistance with the neutral disconnect link temporarily removed. Replace the neutral disconnect link after testing. System neutral-to-ground insulation resistance must be a minimum of 1 megohm. Correct wiring until the minimum is achieved.
    - 2) Perform ground-fault protective-device pickup tests using primary injection. Results of pickup test must be greater than 90 percent of the ground-fault protective-device pickup setting and less than 1200 A or 125 percent of the pickup setting, whichever is smaller. Adjust or replace the device until these parameters are achieved.



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- 3) For summation-type systems utilizing phase and neutral current transformers, verify correct polarities by applying current to each phase-neutral current-transformer pair. This test also applies to MCCBs utilizing an external neutral current transformer. The ground-fault protective device must operate when current direction is the same relative to polarity marks in the two current transformers. The ground-fault protective device must not operate when current direction is opposite relative to polarity marks in the two current transformers.
  - 4) Measure time delay of the ground-fault protective device at a value equal to or greater than 150 percent of the pickup value. Relay timing must be in accordance with manufacturer's published data but must be no longer than one second at 3000 A in accordance with NFPA 70, Article 230, Section 230.95 "Ground-Fault Protection of Equipment."
  - 5) Verify reduced control voltage tripping capability is 55 percent for ac systems and 80 percent for dc systems. Replace the ground-fault system if the reduced control voltage tripping requirement is not achieved, and retest.
  - 6) Retain zone-blocking test in subparagraph below if this feature has been added to Section Text.
  - 7) Verify blocking capability of zone interlock systems. Results of zone-blocking tests must be in accordance with manufacturer's published data and design specifications.
4. Metering Device Field Tests:
- a. Visual and Mechanical Inspection:
    - 1) Inspect physical and mechanical condition.
    - 2) Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
    - 3) Verify the unit is clean.
    - 4) Verify freedom of movement, end play, and alignment of rotating disk(s).
  - b. Electrical Tests:
    - 1) Verify accuracy of meters at cardinal points. Meter accuracy must be in accordance with manufacturer's published data.
    - 2) Calibrate meters in accordance with manufacturer's published data. Calibration results must be within manufacturer's published tolerances.
    - 3) Verify instrument multipliers. Instrument multipliers must be in accordance with system design specifications.
    - 4) Verify that current-transformer and voltage-transformer secondary circuits are intact. Test results must confirm the integrity of the secondary circuits of current and voltage transformers.
5. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
6. Perform the following infrared scan tests and inspections, and prepare reports:



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- a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and rear panels which lack infrared viewing windows so joints and connections are accessible to portable scanner.
- b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

**END OF SECTION 26 24 13**



## **SECTION 26 24 16 - PANELBOARDS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Electronic-grade panelboards.

#### **1.2 MAINTENANCE MATERIAL SUBMITTALS**

**A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.**

1. Keys: 6 spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard where installed.

#### **1.3 QUALITY ASSURANCE**

**A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.**

#### **1.4 WARRANTY**

**A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.**

1. SPD Warranty Period: Five years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### **2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS**

**A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 01 46 00 "Seismic Design Requirements for Nonstructural Systems"**

**B. Enclosures: Flush and Surface-mounted, dead-front cabinets.**

1. Rated for environmental conditions at installed location.



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- a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
  - b. Outdoor Locations: NEMA 250, Type 4.
  - c. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
  - d. Other Wet or Damp and Corrosive Locations: NEMA 250, Type 4.
  - e. Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, [Type 13].
2. Height: 60 inches maximum.
  3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
  4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
  5. Finishes:
    - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Galvanized steel.
    - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- C. Incoming Mains:
1. Location: Top and Bottom.
  2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- D. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
    - a. Bus shall be fully rated the entire length.
  2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
  3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
  5. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.



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2. Terminations shall allow use of 75 deg C rated conductors without derating.
  3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
  4. Main and Neutral Lugs: Compression type, with a lug on the neutral bar for each pole in the panelboard.
  5. Ground Lugs and Bus-Configured Terminators: Compression type, with a lug on the bar for each pole in the panelboard.
  6. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  7. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  8. Gutter-Tap Lugs: Compression type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
  9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
  10. Terminations shall allow the use of conductors at their 75 degree C temperature rating without ampacity rating.
- F. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: 25 percent.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to Section 01 46 00 "Seismic Design Requirements for Nonstructural Systems".
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified." Panelboards on the Essential Power System shall be fully operational following a seismic event.



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- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

## 2.3 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB, Electrification Products Division.
  - 2. Eaton.
  - 3. Square D; Schneider Electric USA.
- B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
  - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- C. Mains: Circuit breaker or Lugs only, as indicated on the Drawings.
- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers; .
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

## 2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB, Electrification Products Division.
  - 2. Eaton.
  - 3. Square D; Schneider Electric USA.
- B. Mains: Circuit breaker or lugs only.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.



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2.5 ELECTRONIC-GRADE PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Products Division.
  2. Eaton.
  3. Square D; Schneider Electric USA.
- B. Panelboards: NEMA PB 1; with factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 and UL 1449 after installing SPD.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- F. SPD.
1. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
  2. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
    - a. Line to Neutral: 700 V for 208Y/120 V.
    - b. Line to Ground: 700 V for 208Y/120 V.
    - c. Neutral to Ground: 700 V for 208Y/120 V.
    - d. Line to Line: 1200 V for 208Y/120 V.
  3. SCCR: Equal to the SCCR of the panelboard in which installed or exceed 100 kA.
  4. Inominal Rating: 20 kA.
- G. Buses:
1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
  2. Copper equipment and isolated ground buses.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Products Division.
  2. Eaton.
  3. Square D; Schneider Electric USA.



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- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers:
    - a. Inverse time-current element for low-level overloads.
    - b. Instantaneous magnetic trip element for short circuits.
    - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 125 A and larger.
  2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  3. Electronic Trip Circuit Breakers, provide for circuits of 250 amps or higher or as required by the Overcurrent Protective Device Coordination Study:
    - a. RMS sensing.
    - b. Field-replaceable rating plug or electronic trip.
    - c. Digital display of settings, trip targets, and indicated metering displays.
    - d. Multi-button keypad to access programmable functions and monitored data.
    - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
    - f. Integral test jack for connection to portable test set or laptop computer.
    - g. Field-Adjustable Settings:
      - 1) Instantaneous trip.
      - 2) Long- and short-time pickup levels.
      - 3) Long and short time adjustments.
      - 4) Ground-fault pickup level, time delay, and I squared T response.
  4. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
  5. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
  6. Subfeed Circuit Breakers: Vertically mounted.
  7. MCCB Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Breaker handle indicates tripped status.
    - c. UL listed for reverse connection without restrictive line or load ratings.
    - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
    - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage. Provide as indicated on the Drawings.
    - h. Rating Plugs: Three-pole breakers with ampere ratings greater than 250 amperes or as required by the Overcurrent Protective Device Study shall have interchangeable rating plugs or electronic adjustable trip units.



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- i. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts. Provide as indicated on the Drawings.
- j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position. Provide as indicated on the Drawings.
- k. Multipole units enclosed in a single housing with a single handle.
- l. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
- m. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position. Provide as indicated on the Drawings.

## 2.7 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

## 2.8 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.



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- B. Comply with NECA 1.
- C. Install panelboards and accessories according to **[NECA 407] [NEMA PB 1.1]**.
- D. Equipment Mounting:
  - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
  - 2. Comply with requirements for seismic control devices specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- E. Comply with mounting and anchoring requirements specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- F. Mount panelboards so that the top of the operating handle of the highest mounted circuit breaker or space is 6 feet or less above finished floor.
- G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

### 3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:



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1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
  - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
  - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
  - c. Instruments and Equipment:
    - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.4 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.



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4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.5 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

**END OF SECTION 26 24 16**



## SECTION 26 27 26 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Receptacles with ground-fault protective devices.
5. Locking receptacles.
6. Special-purpose power outlet assemblies.
7. Connectors, cords, and plugs.

#### 1.2 ALLOWANCES

- A. See Section 01 21 00 "Allowances" for description of allowances affecting items specified in this Section.

#### 1.3 UNIT PRICES

- A. See Section 01 22 00 "Unit Prices" for description of unit prices affecting items specified in this Section.

#### 1.4 ALTERNATES

- A. See Section 01 23 00 "Alternates" for description of alternates affecting items specified in this Section.

#### 1.5 ACTION SUBMITTALS

A. Samples:

1. One for each kind of toggle switch and cover plate accessory specified, in each finish and color specified.
2. One for each kind of key lock switch **and cover plate accessory** specified, in each finish and color specified.
3. One for each kind of maintained-contact switch **and cover plate accessory** specified, in each finish and color specified.



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4. One for each kind of momentary-contact switch **and cover plate accessory** specified, in each finish and color specified.
5. One for each kind of rocker switch **and cover plate accessory** specified, in each finish and color specified.
6. One for each kind of dimmer switch **and cover plate accessory** specified, in each finish and color specified.
7. One for each kind of fan-speed controller switch **and cover plate accessory** specified, in each finish and color specified.
8. One for each kind of single straight-blade receptacle **and cover plate accessory** specified, in each finish and color specified.
9. One for each kind of duplex straight-blade receptacle **and cover plate accessory** specified, in each finish and color specified.
10. One for each kind of duplex straight-blade receptacle with integral switching means **and cover plate accessory** specified, in each finish and color specified.
11. One for each kind of hospital-grade straight-blade receptacle **and cover plate accessory** specified, in each finish and color specified.
12. One for each kind of receptacle with AFCI device **and cover plate accessory** specified, in each finish and color specified.
13. One for each kind of receptacle with AFCI and GFCI devices **and cover plate accessory** specified, in each finish and color specified.
14. One for each kind of receptacle with GFCI device **and cover plate accessory** specified, in each finish and color specified.
15. One for each kind of locking receptacle **and cover plate accessory** specified, in each finish and color specified.
16. One for each kind of pin-and-sleeve receptacle specified, in each finish and color specified.
17. One for each kind of cord connector specified, in each finish and color specified.

1.6 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:
  1. Single straight-blade receptacles.
  2. Duplex straight-blade receptacles.
  3. Duplex straight-blade receptacles with integral switching means.
  4. Receptacles with GFCI device.
  5. Locking receptacles.
- B. Sample warranties.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Items: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.



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1. Extra Keys for Key Lock Switches: One of each kind.
2. SPD Receptacles: Equal to 10 percent of quantity installed for each kind specified, but no fewer than one unit.
3. Controlled Receptacles: Equal to 10 percent of quantity installed for each kind specified, but no fewer than one unit.
4. Cord Connectors: One of each kind.

B. Special Tools:

1. Proprietary equipment and software required to maintain, repair, adjust, or implement future changes to controlled receptacles.
2. Proprietary equipment required to maintain, repair, adjust, or implement future changes to cord connectors.

1.8 WARRANTY FOR DEVICES

A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

A. Toggle Switch :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Leviton Manufacturing Co., Inc.
  - c. Pass & Seymour; Legrand North America, LLC.
  - d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
3. General Characteristics:
  - a. Reference Standards: UL CCN WMUZ and UL 20.
4. Options:
  - a. Device Color: **Ivory**.
  - b. Configuration:
    - 1) General-duty, 120-277 V, 20 A, **single pole**.



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5. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Toggle Switch with Forked Key Lock :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Leviton Manufacturing Co., Inc.
  - c. Pass & Seymour; Legrand North America, LLC.
  - d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
  - b. .
3. General Characteristics:
  - a. Reference Standards: UL CCN WMUZ and UL 20.
4. Options:
  - a. Device Color: **Ivory**.
  - b. Configuration:
    - 1) 120-277 V, 20 A, **single pole**.

C. Rocker Switch :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Leviton Manufacturing Co., Inc.
  - c. Pass & Seymour; Legrand North America, LLC.
  - d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
3. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
4. General Characteristics:
  - a. Reference Standards: UL CCN WMUZ and UL 20.



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5. Options:
  - a. Device Color: **Ivory**.
  - b. Configuration:
    - 1) 120-277 V, 20 A, **single pole**.
6. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

## 2.2 GENERAL-GRADE SINGLE STRAIGHT-BLADE RECEPTACLES

### A. Single Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Leviton Manufacturing Co., Inc.
  - c. Pass & Seymour; Legrand North America, LLC.
  - d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
3. General Characteristics:
  - a. Reference Standards: UL CCN RTRT and UL 498.
4. Options:
  - a. Device Color: **Ivory**.
  - b. Configuration:
    - 1) General-duty, **NEMA 5-20R**.
5. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

### B. Tamper-Resistant, Clock Hanger Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Pass & Seymour; Legrand North America, LLC.



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- b. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
  - 2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
  - 3. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
  - 4. Options:
    - a. Finish: **Ivory nylon.**
    - b. Configuration: Recessed, smooth wallplate; **NEMA 5-20R.**
- C. Tamper-Resistant, Floor-Mounted Display Straight-Blade Receptacle :
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Pass & Seymour; Legrand North America, LLC.
    - b. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
  - 2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
  - 3. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
    - b. Configuration: NEMA 5-15R.
  - 4. Options:
    - a. Finish: **Brush brass.**

## 2.3 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

- A. Duplex Straight-Blade Receptacle :
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Leviton Manufacturing Co., Inc.
    - c. Pass & Seymour; Legrand North America, LLC.
    - d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
  - 2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.



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3. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
  4. Options:
    - a. Device Color: **Ivory**.
    - b. Configuration:
      - 1) General-duty, **NEMA 5-20R**.
  5. Accessories:
    - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.
- B. Tamper-Resistant Duplex Straight-Blade Receptacle :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. A
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Leviton Manufacturing Co., Inc.
    - c. Pass & Seymour; Legrand North America, LLC.
    - d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
  3. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
  4. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
  5. Options:
    - a. Device Color: **Ivory**.
    - b. Configuration:
      - 1) General-duty, **NEMA 5-20R**.
  6. Accessories:
    - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.
- C. Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment :



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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Leviton Manufacturing Co., Inc.
  - c. Pass & Seymour; Legrand North America, LLC.
  - d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
3. General Characteristics:
  - a. Reference Standards: UL CCN RTRT and UL 498.
4. Options:
  - a. Device Color: **Ivory**.
  - b. Configuration:
    - 1) General-duty, **NEMA 5-20R**; two USB-A ports.
5. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Wired Half-Controlled Duplex Straight-Blade Receptacle <I>:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hubbell Incorporated, Lighting.
  - b. Pass & Seymour; Legrand North America, LLC.
  - c. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
3. General Characteristics:
  - a. Reference Standards: UL CCN RTX1 and UL Subject 498B.
4. Options:
  - a. Device Color: **Ivory**.
  - b. Configuration: **NEMA 5-20R**.
5. Accessories:



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- a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.4 RECEPTACLES WITH A GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Leviton Manufacturing Co., Inc.
  - c. Pass & Seymour; Legrand North America, LLC.
  - d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
- 2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 3. General Characteristics:
  - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
- 4. Options:
  - a. Device Color:**Ivory**.
  - b. Configuration: Heavy-duty, **NEMA 5-20R**.
- 5. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Leviton Manufacturing Co., Inc.
  - c. Pass & Seymour; Legrand North America, LLC.
  - d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.



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2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
3. General Characteristics:
  - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
4. Options:
  - a. Device Color: **Ivory**.
  - b. Configuration: Heavy-duty, **NEMA 5-20R**.
5. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

## 2.5 LOCKING RECEPTACLES

### A. NEMA, 125 V, Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Leviton Manufacturing Co., Inc.
  - c. Pass & Seymour; Legrand North America, LLC.
  - d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
3. General Characteristics:
  - a. Reference Standards: UL CCN RTRT and UL 498.
4. Options:
  - a. Device Color: Black with yellow voltage indication on face.
  - b. Configuration: 2 pole, 3 wire, grounding, **NEMA L5-20R**.

### B. NEMA, 250 V, Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Leviton Manufacturing Co., Inc.



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- c. Pass & Seymour; Legrand North America, LLC.
  - d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
2. Regulatory Requirements:
- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
3. General Characteristics:
- a. Reference Standards: UL CCN RTRT and UL 498.
4. Options:
- a. Device Color: Black with blue voltage indication on face.
  - b. Configuration:
    - 1) 2 pole, 3 wire, grounding, **NEMA L6-20R.**

## 2.6 CONNECTORS, CORDS, AND PLUGS

### A. Outdoor-Use, Watertight, Sealed Cord Connector :

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
- a. Ericson Manufacturing Company.
2. Regulatory Requirements:
- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
3. General Characteristics:
- a. Reference Standards: UL CCN AXUT and UL 498.
4. Options:
- a. Configuration:
    - 1) NEMA 5-20.

**END OF SECTION 26 27 26**



## SECTION 26 28 13 - FUSES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches and fuse holders.
  - 2. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
  - 3. Spare-fuse cabinets.
- B. Related Sections include the following:
  - 1. Division 26 Section "Enclosed Switches and Circuit Breakers."

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  - 3. Current-limitation curves for fuses with current-limiting characteristics.
  - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.]
  - 5. Coordination charts and tables and related data.
  - 6. Fuse sizes for elevator feeders and elevator disconnect switches.



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- B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Ambient temperature adjustment information.
  2. Current-limitation curves for fuses with current-limiting characteristics.
  3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
  4. Coordination charts and tables and related data.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

#### 1.5 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Bussmann, Inc.
  2. Edison Fuse, Inc.
  3. Shawmut, Inc.
  4. Littelfuse, Inc.



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2.2 PLUG FUSES

- A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

2.3 PLUG-FUSE ADAPTERS

- A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuse holders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Plug Fuses:
  - 1. Motor Branch Circuits: Type S, dual-element time delay.
  - 2. Other Branch Circuits: Type S, dual-element time delay.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install plug-fuse adapters in Edison-base fuse holders and sockets. Ensure that adapters are irremovable once installed.



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3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

3.5 SCHEDULES

- A. Type FA: Fusetron FRN, 250 volt, 15-600 amp.
- B. Type FC: Low-Peak LPN, 250 volt, 15-600 amp.
- C. Type FF: Limitron KTN, 250 volt, 15-600 amp.

**END OF SECTION 26 28 13**



## **SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance:** Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to Section 01 46 00 "Seismic Design Requirements for Nonstructural Systems".
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

#### **2.2 GENERAL REQUIREMENTS**

- A. Source Limitations:** Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space:** Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.**



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2.3 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Products Division.
  2. Eaton.
  3. Square D; Schneider Electric USA.
  4. Approved equal
- B. Type HD, Heavy Duty:
1. Single throw.
  2. Three pole.
  3. 600-V ac.
  4. 1200 A and smaller.
  5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
  6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
  4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  5. Auxiliary Contact Kit: NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
  6. Hookstick Handle: Allows use of a hookstick to operate the handle.
  7. Lugs: Mechanical type, suitable for number, size, and conductor material.
  8. Service-Rated Switches: Labeled for use as service equipment.

2.4 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Products Division.
  2. Eaton.
  3. Square D; Schneider Electric USA.
  4. Approved equal.



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- B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
  - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  - 5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
  - 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
  - 7. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.5 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB, Electrification Products Division.
  - 2. Eaton.
  - 3. NOARK Electric North America.
  - 4. Square D; Schneider Electric USA.
  - 5. Approved Equal.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated or series rated as indicated on the Drawings. combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated



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combination used shall be marked on the end-use equipment along with the statement "Caution - Series Rated System. \_\_\_\_\_ Amps Available. Identical Replacement Component Required."

- E. MCCBs shall be equipped with a device for locking in the isolated position.
- F. Lugs shall be suitable for.
- G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  - 1. Instantaneous trip.
  - 2. Long- and short-time pickup levels.
  - 3. Long- and short-time time adjustments.
  - 4. Ground-fault pickup level, time delay, and I-squared t response.
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- M. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- N. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- O. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
  - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
  - 4. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and



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- time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system, specified in Section 26 09 13 "Electrical Power Monitoring and Control."
  6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
  7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  8. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  9. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
  10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  11. Zone-Selective Interlocking: Integral with ground-fault trip unit; for interlocking ground-fault protection function.
  12. Electrical Operator: Provide remote control for on, off, and reset operations.
  13. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

## 2.6 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. ABB, Electrification Products Division.
  2. Eaton.
  3. Square D; Schneider Electric USA.
  4. Approved Equal.
- B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- D. Features and Accessories:
  1. Standard frame sizes and number of poles.
  2. Lugs:
    - a. Compression type, suitable for number, size, trip ratings, and conductor material.
    - b. Lugs shall be suitable for 167 deg F rated wire.
  3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.



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4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
7. Alarm Switch: One NO contact that operates only when switch has tripped.
8. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
10. Electrical Operator: Provide remote control for on, off, and reset operations.
11. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

## 2.7 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

## PART 3 - EXECUTION

### 3.1 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.



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1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 4X.
3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
6. Hazardous Areas Indicated on Drawings: NEMA 250,.

### 3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections for Switches:
  1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, grounding, and clearances.
    - c. Verify that the unit is clean.
    - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
    - e. Verify that fuse sizes and types match the Specifications and Drawings.
    - f. Verify that each fuse has adequate mechanical support and contact integrity.
    - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
      - 1) Use a low-resistance ohmmeter.
        - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
        - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.



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- h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
  - i. Verify correct phase barrier installation.
  - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
  - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
  - e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

F. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:
- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
  - b. Inspect physical and mechanical condition.
  - c. Inspect anchorage, alignment, grounding, and clearances.
  - d. Verify that the unit is clean.
  - e. Operate the circuit breaker to ensure smooth operation.
  - f. Inspect bolted electrical connections for high resistance using one of the two following methods:
    - 1) Use a low-resistance ohmmeter.
      - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.



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- a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
  - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
  - h. Perform adjustments for final protective device settings in accordance with the coordination study.
- 2. Electrical Tests:
  - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
  - c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
  - e. Determine the following by primary current injection:
    - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
  - f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
  - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.



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- h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
    - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
  - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 4. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
    - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- G. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- H. Prepare test and inspection reports.
  - 1. Test procedures used.
  - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
  - 3. List deficiencies detected, remedial action taken, and observations after remedial action.

### 3.3 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73.16 "Coordination Studies."

**END OF SECTION 26 28 16**



## SECTION 26 29 13.03 - MANUAL AND MAGNETIC MOTOR CONTROLLERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Manual motor controllers.
2. Enclosed full-voltage magnetic motor controllers.
3. Combination full-voltage magnetic motor controllers.
4. Enclosed reduced-voltage magnetic motor controllers.
5. Combination reduced-voltage magnetic motor controllers.
6. Multispeed magnetic motor controllers.
7. Combination multispeed magnetic motor controllers.
8. Enclosures.
9. Accessories.
10. Identification.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
- C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

#### 2.2 MANUAL MOTOR CONTROLLERS

- A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. ABB, Motion Division.
  - b. Eaton.
  - c. Rockwell Automation, Inc.
  - d. Square D; Schneider Electric USA.



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2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:  
:
    - a. ABB, Electrification Products Division.
    - b. ABB, Motion Division.
    - c. Eaton.
    - d. Rockwell Automation, Inc.
    - e. Square D; Schneider Electric USA.
- C. Integral Horsepower Manual Controllers (IHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ABB, Electrification Products Division.
    - b. ABB, Motion Division.
    - c. Eaton.
    - d. Rockwell Automation, Inc.
    - e. Square D; Schneider Electric USA.

## 2.3 ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS

- A. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Products Division.
  2. ABB, Motion Division.
  3. Eaton.
  4. Rockwell Automation, Inc.
  5. Square D; Schneider Electric USA.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

## 2.4 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

- A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.



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B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Products Division.
2. ABB, Motion Division.
3. Eaton.
4. Rockwell Automation, Inc.
5. Square D; Schneider Electric USA.

C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

## 2.5 ENCLOSURES

- A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.
- B. The construction of the enclosures shall comply with NEMA ICS 6.
- C. Controllers in hazardous (classified) locations shall comply with UL 1203.

**END OF SECTION 26 29 13.03**



## **SECTION 26 32 13 - ENGINE GENERATORS**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION**

- A. This section specifies the furnishing, complete installation, connection and testing of the 200 Kw, 480/277V emergency engine generator system. Including air filtration, starting system, generator controls, instrumentation, lubrication, fuel system, cooling system and exhaust system, Weatherproof enclosure, 50% radiator mounted load bank and Tier 2 compliant exhaust system.
- B. The engine generator system shall be fully automatic and shall constitute a unified and coordinated system ready for operation.
- C. The engine generator system shall include, but not be limited to the following:
  - 1. Diesel Engine.
  - 2. Lubrication Oil System.
  - 3. Fuel Oil System (24hour integral belly tank).
  - 4. 42" wide platform and stairs on both sides of generator to facilitate access.
  - 5. Cooling System.
  - 6. Tier 2 compliant Intake and Exhaust Air System including a high particulate air filter to comply with local AQMD requirements.
  - 7. Starting System.
  - 8. Generator.
  - 9. Controls, Supervision and Distribution.
  - 10. Level 1 Sound attenuated weatherproof enclosure.
  - 11. Integral radiator mounted 50% rated load bank.
  - 12. Spare Parts.

#### **1.2 RELATED WORK**

- A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW: Cables and Wiring.
- D. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Requirements for automatic transfer switches.



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- E. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS:  
Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

### 1.3 QUALITY ASSURANCE

- A. The supplier of the diesel-engine generator set shall be responsible for satisfactory total operation of the system and its certification. This supplier shall have had experience with three or more installations of systems of comparable size and complexity in regards to coordinating, engineering, testing and supervising. Each of these installations shall have been in successful operation for three or more years.
- B. Factory authorized representative shall be capable of providing emergency maintenance and repairs at the project site within 8 hours maximum of notification.
- C. Engine generator and auxiliary components shall be supplied from a single manufacturer.
- D. Noise level developed by the generator set shall be as herein specified.

### 1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Data shall be submitted in the following form:
    - a. Technical data sheets (TDS): These include published performance, rating and derating curves, published ratings, catalog cuts, pictures, manufacturer's specifications, material composition, and gauge thickness.
    - b. Description of operation (DO): Manufacturer's literatures and, if suitable, diagrams.
    - c. Calculations (CALC): Detailed engineering calculations with all equations, graphs, assumptions, and approximations shown, and data sources referenced.
    - d. Certification (CERT): Written confirmation as to the document's accuracy, and genuineness.
    - e. Shop Drawings (SD): Scaled drawings showing plan views, side views, elevations and cross sections.
    - f. Diagrams (DGM): These include control system diagrams, elementary diagrams, control sequence diagrams or table, wiring diagrams, interconnections diagrams (between local control cubicles, remote annunciator panels, remote derangement panels, remote monitoring panels, remote exercising panel and underground fuel storage tanks),



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wireless connection diagrams, illustrative diagrams, flow diagrams, and other like items.

3. Prior to fabrication, submit for approval the following data for each engine-generator set, transfer device and control and supervisory equipment:
  - a. Engine generator set: TDS, SD, including subtransient reactance and short-circuit current capacity.
  - b. Engine jacket water heaters: TDS
  - c. Muffler assembly: TDS, SD
  - d. Motor-operated damper assembly: TDS
  - e. Day tank and pumps or integral sub-base fuel tank: TDS, CALC
  - f. Batteries, racks and charger: TDS, CALC
  - g. Torsional Vibration: CERT
  - h. Control and Supervisory Equipment: TDS, DGM, DO, SD
  - i. Performance:
    - 1) Voltage regulating equipment: TDS
    - 2) Frequency regulating equipment: TDS
    - 3) Voltage and frequency dips and recovery times due to specified motor loading: CALC
    - 4) Antifreeze derating: TDS
    - 5) Ambient derating: TDS
  - j. Fuel oil system: DGM
  - k. Cooling system: DGM
  - l. Vibration isolators: TDS, CALC
  - m. Sound power level data for the packaged outdoor generator.
  - n. Vibration isolation system performance data from no-load to full-load. This must include seismic qualification of the engine-generator mounting, base and vibration isolation.

C. Manuals:

1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals of the engine generator set and auxiliaries including technical data sheets, wiring diagrams, and information, such as telephone number, fax number, and web sites, for ordering replacement parts.
2. Two weeks prior to the final inspection, submit electronic copies of the updated maintenance and operating manual to the Architect/Engineer:
  - a. Include complete "As installed" diagrams, which indicate all items of equipment and their interconnecting wiring.
  - b. Include complete diagrams of the internal wiring for each of the items of equipment, including "As installed" revisions of the diagrams.
  - c. The wiring diagrams shall identify the terminals to facilitate installation, maintenance, operation and testing.
  - d. Complete lists of spare parts and special tools recommended for two years of normal operation of the complete system.

D. Certifications:



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1. Prior to fabrication of the engine-generator set, submit the following for approval, to the Architect/Engineer:
  - a. A certification in writing that a diesel engine of the same model and configuration, with the same bore, stroke, number of cylinders, and equal or higher BMEP and RPM ratings as the proposed diesel engine has been operating satisfactorily, with connected loads of not less than 75 percent of the specified KW/KVA rating, for not less than 2,000 hours without any failure of a crankshaft, camshaft, piston, valve, injector or governor system.
  - b. A certification in writing that devices and circuits will be incorporated to protect the voltage regulator and other components of the auxiliary electrical power system during operation of the diesel engine-generator set at speeds other than the rated RPM while performing maintenance. Include thorough descriptions with submittal of any precautions, which will be necessary to protect the voltage regulator and other components of the system during operation of the diesel engine-generator set at speeds other than the rated RPM.
2. Prior to installation of the engine-generator set at the job site, submit electronic copies of the following to the Architect/Engineer:
  - a. Certified test data, alternator temperature rise test and strip chart recordings, and photographs showing test setup and equipment.
3. Two weeks prior to the final inspection, submit electronic copies of the following, to the Architect/Engineer.:
  - a. Certified test report by the manufacturer of the engine-generator set that the auxiliary electrical power system conforms to the requirements of the drawings and specifications.
  - b. Certified report of field tests from the contractor that the engine-generator set and major auxiliaries have been properly installed, adjusted and tested.
  - c. A certificate by the manufacturer that the engine-generator set, accessories, and components will withstand the seismic design category 4 and Structural seismic design criteria established for the site and that the set will be fully operational after the seismic event at the project site.

E. Information Submittals

- a. Qualification Data: For qualified testing agency.
- b. Seismic Qualification Certificates: Submit certification that generator and generator sound attenuated enclosure, accessories, and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems." Include the following:
  - 1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- c. Qualification Data: For professional engineer for seismic support calculations and details and testing agency.



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1.5 STORAGE AND HANDLING

- A. Equipment shall withstand the mechanical stresses caused by rough handling during shipment in addition to the electrical and mechanical stresses, which occur during operation of the system. Protect radiator core with wood sheet.
- B. Store the equipment in a location approved by the Architect/Engineer.

1.6 JOB CONDITIONS

- A. Shall conform to the arrangements and details shown on the drawings. The dimensions, enclosures and arrangements of the engine-generator set shall permit the operating personnel to safely and conveniently operate and maintain the system in the space designated for installation.
- B. Unless specified otherwise, each component of the engine-generator system shall be capable of operating as specified herein at 500 meters (1590 feet) above sea level in a ventilated enclosure which will have average ambient air temperatures ranging from a minimum of – 12 degrees C (20 degrees F) in winter to maximum of 40 degrees C (104 degrees F) in summer.

1.7 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American National Standards Institute (ANSI):
  - 1. C37.50-00 Low-Voltage AC Power Circuit Breakers used In Enclosures-Test Procedures
- C. American Society of Testing Materials (ASTM):
  - 1. A53/A53M-04 Standard Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc Coated Welded and Seamless.
  - 2. B88-03 Specification for Seamless Copper Water Tube
  - 3. B88M-03 Specification for Seamless Copper water Tube (Metric)
- D. Institute of Electrical and Electronic Engineers (IEEE):
  - 1. C37.13-95 Low Voltage AC Power Circuit Breakers Used In Enclosures
  - 2. C37.90.1-02 Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- E. National Electrical Manufacturers Association (NEMA):



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1. AB 1-02 Molded Case Circuit Breakers and Molded Case Switches and Circuit Breaker Enclosures
2. ICS 6-01 Industrial Control and Systems: Enclosures
3. ICS 4-05 Terminal Blocks,
4. MG 1-04 Motor and Generators
5. MG 2-01 Safety Standard and Guide for Selection, Installation and use of Electric Motors and Generators
6. PB 2-01 Dead-Front Distribution Switchboards
7. SG 3-95 Low Voltage Power Circuit Breakers-Power Switching Equipment
8. SG 5-95 Power Switchgear Assemblies
9. 250-03 Enclosures for Electrical Equipment (1000 Volts Maximum)

F. National Electrical Testing Association (NETA):

1. ATS-95 Electrical Power Distribution Equipment and Systems

G. National Fire Protection Association (NFPA):

1. 30-03 Flammable and Combustible Liquids Code.
2. 37-02 Installations and Use of Stationary Combustion Engine and Gas Turbines
3. 70-05 National Electrical Code (NEC)
4. 99-05 Health Care Facilities
5. 110-05 Standard for Emergency and Standby Power Systems.

H. Underwriters Laboratories, Inc. (UL):

1. 50-03 Enclosures for Electrical Equipment
2. 142-02 Steel Aboveground Tanks for Flammable and Combustible liquids
3. 2085-95 Insulated Aboveground Tanks for Flammable and Combustible Liquids
4. 2200-04 Stationery Engine Generator Assemblies
5. 1236-02 Battery Charges for Charging Engine-Starter Batteries
6. 467-04 Grounding and Bonding Equipment.
7. 489-04 Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
8. 508-05 Industrial Control Equipment
9. 891-03 Dead-Front Switchboards

## PART 2 - PRODUCTS

### 2.1 DIESEL ENGINE-GENERATOR SET

A. Acceptable manufacturers:

1. Caterpillar Generators
2. Kohler
3. Cummins



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- B. The engine generator system shall be in accordance with NFPA, UL, NEMA and ANSI, and as specified and as shown on the drawings.
- C. Provide a factory-assembled, wired, (except for the field connections), complete, fully automatic emergency diesel engine-generator system.
- D. Published Rating:
  - 1. Generators shall be not less than 200 KW Standby at 480/277, 3-phase, 4-wire, 60 Hz and 0.80 power factor.
- E. Assemble, connect and wire the equipment at the factory so that only the external connections need to be made at the construction site.
- F. Unit shall be factory painted with manufacturer's primer and standard finishes.
- G. Coordinate the components of the system and their arrangements, electrically and mechanically.
- H. Connections between components of the system shall conform to the recommendations of the manufacturer of the diesel engine-generator set.
- I. Couplings, shafts, and other moving parts shall be enclosed and guarded. Guards shall be metal, ruggedly constructed, rigidly fastened and readily removable for convenient servicing of the equipment without disassembling any pipes and fittings.
- J. Generator set and cooling system shall be furnished with extended life antifreeze solution to protect the system from freezing at all times.
- K. Generator set shall have the following features:
  - 1. Factory-mounted on a common, rigid, welded, structural steel base.
  - 2. The maximum engine-generator set vibration in the horizontal, vertical, and axial directions shall be limited to 0.15mm with an overall velocity limit of 24 mm/sec RMS, for all speeds.
  - 3. The isolators shall be constrained with restraints capable of withstanding static forces in any direction equal to twice the weight of the supported equipment.
  - 4. Automatic start, accelerate to the specified RPM and deliver the specified KW/KVA output at 60 Hz within 10 seconds after a single pole contact closes in a remote device.
  - 5. Recover rapidly from instantaneous changes between no load and the specified KW/KVA rating, and the reverse changes of load, without damage.
  - 6. Shall be capable of operating satisfactorily as specified for not less than 10,000 hours between major overhauls.
  - 7. Engine-generator set shall be statically and dynamically balanced at the factory in order to comply with the maximum vibration velocity specified in paragraph 3.1.D.



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2.2 DIESEL ENGINE

- A. Coupled directly to a generator.
- B. Minimum 4-cylinders.
- C. Operating speed shall be 1800 RPM.
- D. BMEP for the diesel engine, while the engine-generator set is delivering 100 percent of its specified output, shall not exceed the following maximum limits:
- E. The minimum cubic inch displacement of the engine shall not be less than the value calculated from the following equation:
  - 1.  $\text{Displacement} = \frac{\text{BHP} \times \text{K}}{\text{BMEP} \times \text{RPM}}$
  - 2.
  - 3. Where  $\text{BHP} = \frac{\text{Specified KW}}{0.746} + \text{R}$
  - 4.
  - 5.  $\text{K} = 396,000$  for 2-cycle engines
  - 6.  $\text{K} = 792,000$  for 4-cycle engines
  - 7.  $\text{BMEP} = \text{Values specified above}$
  - 8.  $\text{RPM} = 1800$
  - 9.  $\text{G} = \text{generator efficiency expressed as a decimal}$
  - 10.  $\text{R} = \text{horsepower of radiator fan}$
  - 11.  $\text{R} = 0$ , when electric motor driven radiator fan is herein specified
- F. The engine shall be able to start in a 4.5 degrees C (40 degrees F) ambient temperature while using No. 2 diesel fuel oil without the use of starting aids such as glow plugs and ether injections.
- G. Fuel oil consumption of the engine rate shall not exceed 0.4 pounds of fuel oil per BHP per hour when it delivers 100 percent of its specified KW/KVA rating.
- H. Equipped with electric heaters for maintaining the engine's coolant temperature in the range of 32-38 degrees C (90-100 degrees F) as recommended by the manufacturer.
  - 1. Install thermostatic controls, contactors, and circuit breaker protected circuits for the heaters.
  - 2. The heaters shall operate continuously except while the engine is operating or the water temperature is at the predetermined level.

2.3 GOVERNOR

- A. Provide an isochronous governor.
- B. Steady-state speed band at 60 Hz shall not exceed plus or minus 1/3 of one percent.



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- C. At 60 Hz, when load changes equal to 25 percent of the specified KW/KVA rating, frequency change shall not exceed two percent and it shall recover to 60 Hz within three seconds.
- D. At 60 Hz, when load changes equal to 100 percent of the specified KW/KVA rating, frequency change shall not exceed eight percent and it shall recover to 60 Hz within five seconds.
- E. While the engine is running, manual speed adjustments may be made.

## 2.4 LUBRICATION OIL SYSTEM

- A. Pressurized type.
- B. Positive-displacement pump driven by engine crankshaft.
- C. Full-flow strainer and full-flow or by-pass filters.
- D. Filters shall be cleanable or replaceable type and shall remove particles as small as 3 microns without removing the additives in the oil. For by-pass filters, flow shall be diverted without flow interruption.
- E. Extend lube oil sump drain line passing out through the skid base and terminate it with a drain valve and plug.
- F. Provide a 208-volt oil heater for exterior generator set and 120- volt oil heater for interior generator set.

## 2.5 FUEL OIL SYSTEM

- A. Shall comply with NFPA 37 and NFPA 30, and have the following features:
  - 1. Injection pump(s) and nozzles.
  - 2. Plungers shall be carefully lapped for precision fit and shall not require any packing.
  - 3. Filters or screens, which require cleaning or replacement, will not be permitted in the injection system assemblies.
  - 4. Return surplus oil from the injectors to the main storage tank by gravity or a pump.
  - 5. Filter System:
    - a. Dual primary filters shall be located between the main fuel oil storage and day tank.
    - b. Secondary filters (engine mounted) shall be located so the oil will be thoroughly filtered before it reaches the injection system assemblies.
    - c. Filters shall be cleanable or replaceable type and shall entrap and remove water from oil as recommended by the engine manufacturer.



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B. Integral Belly Tank 200 kW Generator:

1. Capacity of the day tank shall be not less than:
  - a. 24 hours fuel consumption.
2. Shall be welded steel, UL approved.
3. Secure, pipe and connect the tank adequately for maximum protection from fire hazards, including oil leaks.
4. Incorporate a vent, drain cock, shutoff cocks and gauge glass. Terminate the vent piping outdoors with mushroom vent cap.
5. Incorporate a float switch on the day tank to control the fuel oil transfer pump and to actuate an alarm in the engine generator control cubicle when the oil level in the tank drops below the level at which the transfer pump should start to refill the tank.
  - a. The float switch contacts, which control the fuel oil transfer pump, shall be set to energize the pump when the liquid level in the tank reaches 1/3 of the total volume of the tank.
  - b. The float switch contacts, which actuate the low fuel oil day tank alarm device, shall be set to alarm and energize the second fuel transfer pump when the liquid level in the tank reaches 1/4 of the total volume of the tank.
6. Provide fuel tank fuel level alarms for low level, low low level, high level and high high level alarm outputs.
7. Provide fuel tank fuel leak detection alarm outputs.

2.6 ENGINE COOLING SYSTEM

- A. Liquid-cooled, closed loop, with radiator mounted on the engine generator set and integral engine driven circulating pump // as shown on the drawings.
- B. Cooling capacity shall not be less than the cooling requirements of the engine-generator set and its lubricating oil while operating continuously at 110 percent of its specified rating.
- C. Coolant shall be extended life antifreeze solution, 50 percent ethylene and 50 percent soft water, with corrosion inhibitor additive as recommended by the manufacturer
- D. Radiator core tubes material shall be as recommended by the engine manufacturer.
- E. Fan shall be driven by multiple belts from engine shaft.
- F. Coolant hoses shall be flexible per manufacturer's recommendation.
- G. Self-contained thermostatic-control valve shall modulate coolant flow to maintain optimum constant coolant temperature as recommended by the engine manufacturer.



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2.7 AIR INTAKE AND EXHAUST SYSTEMS

A. Air Intake:

1. Provide an engine-mounted air cleaner with replaceable dry filter and dirty filter indicator.

B. Tier 1 Compliant Exhaust System:

1. A Tier 1 compliant exhaust system shall be provided in accordance with the local AQMD requirements. The exhaust system controls shall provide an alarm if the exhaust system emissions exceed the allowable limits established by the local authority. The emergency generator shall remain operational at all times regardless of exhaust emission conformance to the Tier 1 requirements.
2. Where turbo-charges are required, they shall be engine-mounted, driven by the engine gases, securely braced against vibration and adequately lubricated by the engine's filtered lubrication system.
3. Pressure drop in the complete exhaust system shall be small enough for satisfactory operation of the engine-generator set while it is delivering 110 percent of its specified rating.
4. Exhaust pipe size, from the engine to the muffler, shall be as recommended by the engine manufacturer. Pipe size from muffler to air discharge shall be two-pipe sizes larger than engine exhaust pipe.
5. Connections at the engine exhaust outlet shall be made with a flexible exhaust pipe. Provide bolted type pipe flanges welded to each end of the flexible section.

C. Condensate drain at muffler shall be made with schedule 40 black steel pipe through a petcock.

D. Exhaust Piping and Supports: Black steel pipe, ASTM A-53 standard weight with welded fittings. Spring type hangers, as specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT, shall support the pipe.

E. Insulation for Exhaust Pipe and Muffler:

1. Calcium silicate minimum 75 mm (3 inches) thick.
2. Insulation shall be as specified in Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
3. The installed insulation shall be covered with aluminum jacket 0.4 mm (0.016 inch) thick. The jacket is to be held in place by bands of (0.38 mm) (0.015 inch) thick by 15 mm (0.5 inch) wide aluminum.
4. Insulation and jacket are not required on flexible exhaust sections.

2.8 ENGINE STARTING SYSTEM

A. Shall start the engine at any position of the flywheel.



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B. Electric cranking motor:

1. Shall be engine-mounted.
2. Shall crank the engine via a gear drive.
3. Rating shall be adequate for cranking the cold engine at the voltage provided by the battery system, and at the required RPM during five consecutive starting attempts of 10 seconds cranking each at 10 second intervals, for a total of 50 seconds of actual cranking without damage.

C. Batteries: 24 volt electric with the following features:

1. Batteries shall be nickel-cadmium high discharge rate type.
2. Each battery cell shall have minimum and maximum electrolyte level indicators, and flip top flame arrestor vent cap.
3. Batteries shall have connector covers for protection against external short circuits.
4. With the charger disconnected, the batteries shall have sufficient capacity so that the total system voltage does not fall below 85 percent of the nominal system voltage with the following demands:
  - a. Five consecutive starting attempts of 10 seconds cranking at 10 second intervals for a total of 50 seconds of actual cranking (the fifth starting attempt will be manually initiated upon failure of a complete engine cranking cycle).
5. Battery racks shall be metal with an alkali resistant finish and thermal insulation, and secured to the floor.
6. Battery shall operate continuously for 12 hours and be able to provide the cranking power described in 2.8.B.3 without charging.

D. Battery Charger:

1. The charger shall maintain one percent voltage regulation from no load to full load for line voltage variation of 10 percent and frequency variation of  $\pm 3$  Hz from 60 Hz.
2. The charger shall maintain a nominal float voltage of 1.4 vdc and a nominal equalizing voltage of 1.6 vdc.
3. The charger shall be capable of continuous operation in an ambient temperature of  $-20$  to  $60$  degrees C ( $-30$  to  $104$  degrees F) without derating. The charger shall be convection cooled and housed in a NEMA 250, Type 1 enclosure. The charger shall have a hinged front door and all components shall be accessible from the front.
4. Provide both AC and DC transient protection. Charger shall be able to recharge a fully discharged battery without tripping AC protective devices. AC circuit breaker shall not trip under any DC load condition including short circuit on output terminals.
5. The charger shall be capable of recharging the fully discharged battery in 12 hours and simultaneously power the Supervisory and Control panel.
6. The charger shall have fused AC input and DC output protection, and shall not discharge the batteries when AC power fails.



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7. The charger shall have the following accessories:
  - a. On-Off control switch with pilot light.
  - b. Hand adjustable 0 to 24 hour equalize charge timer.
  - c. AC power failure alarm light.
  - d. High DC voltage alarm light.
  - e. DC voltmeter – 5 percent accuracy.
  - f. DC Ammeter – 5 percent accuracy.

2.9 GENERATOR

- A. Synchronous, amortisseur windings, bracket-bearing, self-venting, rotating-field type connected directly to the engine.
- B. Lifting lugs designed for convenient connection to and removal from the engine at the construction site.
- C. Integral poles and spider, or individual poles dove-tailed to the spider.
- D. Insulation shall be as required for the ambient temperature and other requirements designated in the paragraph, DIESEL ENGINE-GENERATOR SET, in this section.
- E. Designed for sustained short circuit currents in conformance with NEMA Standards.
- F. Designed for sustained operation at 125 percent of the RPM specified for the generator set without damage.
- G. Telephone influence factor shall conform to NEMA Standards.
- H. Furnished with brushless excitation system or static-exciter-regulator assembly.
- I. Nameplates attached to the generator and exciter shall show the manufacturer's name, equipment identification, serial number, voltage ratings, field current ratings, KW/KVA output ratings, power factor rating, time rating, temperature rise ratings, RPM ratings, full load current rating, number of phases and frequency, and date of manufacture.
- J. At full load, the efficiency shall be not less than:
  1. 89 percent for sets specified from 60 KW to 175 KW.
  2. 92 percent for sets specified over 175 KW.
- K. The neutral shall be electrically isolated from equipment ground and terminated in same junction box as the phase conductors.
- L. Generator output breakers shall be separated and compartmentalized for separation between the life safety and optional standby output breakers.
- M. EQUIPMENT FOR CONTROLS, SUPERVISION AND DISTRIBUTION



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N. Shall include Engine Generator Control Panel and Remote Annunciator Panel.

1. Control Equipment shall be in accordance with UL 508, NEMA ICS-4, ICS-6 and ANSI C37.90.1.
2. Panels shall be in accordance with UL 50.
3. Incorporate all of the items required to fulfill the requirements in the specifications and on the drawings.
4. Components:
  - a. Shall be heavy duty, industrial type.
  - b. Electrical contacts shall be precious metal surfaced.
  - c. Only heavy duty solid-state components will be accepted.
5. Coordinate controls with the automatic transfer devices shown on the drawings, so that the systems will operate as specified.
6. Wiring: Insulated, rated at 600 volts, UL approved.
  - a. Install the wiring in vertical and horizontal runs, neatly harnessed.
  - b. Terminate all external wiring at heavy duty, pressure type, terminal blocks.
7. Clearly and permanently label the equipment, wiring terminals and wires.
8. Laminate or mount under plexiglas appropriate wiring diagrams and mount them within the frame on the inside of the cubicles and panels.
9. The system shall be designed and manufactured employing the most modern technology to insure maximum reliability and longevity. It shall be arranged for automatic and manual starting, and stopping, and paralleling of up to 3 diesel generator sets.
10. All indicating lamps and switches shall be accessible and mounted on the cubicle doors.
11. Electronic governor control panel, voltage regulator, control panel, motorized voltage adjusting potentiometer, and associated components shall be shipped to the generator control switchboard manufacturer for assembly, mounting and/or interwiring in the switchboard. Detailed drawings outlining proper interconnection and physical mounting data shall also be furnished to the generator switchboard manufacturer to facilitate proper design and interfacing. The engine generator set supplier shall furnish these items as soon as possible.
12. All meters shall be solid-state switchboard type, 112 mm (4-1/2 inches), 1 percent accuracy transformer rated for 600 volt service. Ammeters and voltmeters shall be furnished with phase selector switches. Metering shall include necessary current and potential transformers and instrument fuses.
13. The repetitive accuracy of the monitors shall be as stated over an environmental temperature range of 0 to 45 degrees C (32 to 113 degrees F) and voltage range of 70 to 110 percent of nominal. The accuracy shall not exceed the following limits:

Voltage Monitors	+ 2 percent of set point
Current Monitors	+ 3 percent of set point
Frequency Monitors	+ 0.2 Hz.
Power Monitors	+ 3 percent of set point



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14. The manufacturer shall coordinate the interfacing of the control systems with all related equipment supplied in accordance with other sections of the project specification.

O. Engine Generator Control Cubicle

1. Starting and Stopping Controls:
  - a. A three-position, maintained-contact type selector switch with positions marked "AUTOMATIC", "OFF" and "MANUAL". Provide flashing amber light for "OFF" and "MANUAL" positions.
  - b. A momentary contact pushbutton switch with positions marked "MANUAL START" and "MANUAL STOP".
  - c. Selector switch in "AUTOMATIC" position shall cause the engine to start automatically when a single pole contact in a remote device closes. When the generator's output voltage increases to not less than 90 percent of its rated voltage, and its frequency increases to not less than 58 Hz, the remote devices shall transfer the load to the generator. An adjustable time delay relay, 0 to 15 minute range, shall cause the engine generator set to continue operating without any load after completion of the period of operation with load. Upon completion of the additional 0 to 15 minute (adjustable) period, the engine generator set shall stop.
  - d. Selector switch in "OFF" position shall prevent the engine from starting either automatically or manually. Selector switch in "MANUAL" position shall cause the engine to start when the manual start pushbutton is also depressed momentarily.
  - e. With selector switch in "MANUAL" position, depressing the "MANUAL STOP" pushbutton momentarily shall stop the engine after a cool down period.
  - f. A maintained contact, red mushroom head pushbutton switch marked "EMERGENCY STOP" will cause the engine to stop without a cool down period independent of the position of the selector switch.
2. Engine Cranking Controls:
  - a. The cranking cycles shall be controlled by timer that will be independent of the battery voltage fluctuations.
  - b. Shall crank the engine through one complete cranking cycle, consisting of four starting attempts of 10 seconds each and 10 seconds between each attempt.
  - c. Total actual cranking time for the complete cranking cycle shall be 40 seconds during a 70 second interval.
  - d. Cranking shall terminate when the engine starts so the starting system will not be damaged. Termination of the cranking shall be controlled by self-contained, speed-sensitive switch. The switch shall prevent re-cranking of the engine until after the engine stops.
  - e. After the engine has stopped the cranking control shall reset.
3. Supervisory Controls:
  - a. Overcrank:



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- 1) When the cranking control system completes one cranking cycle, four starting attempts, without starting the engine, the "overcrank" signal light and the audible alarm shall be energized.
- 2) The cranking control system shall lock-out, and shall require a manual reset.
- b. Coolant Temperature:
  - 1) When the temperature rises to the predetermined first stage level, the "HIGH COOLANT TEMPERATURE - FIRST STAGE" signal light and the audible alarm shall be energized.
  - 2) When the temperature rises to the predetermined second stage level, which shall be low enough to prevent any damage to the engine and high enough to avoid unnecessary engine shutdowns, the "HIGH COOLANT TEMPERATURE - SECOND STAGE" signal light and the audible alarm shall be energized and the engine shall stop.
  - 3) Difference between the first and second stage temperature settings shall be approximately -12 degrees C (10 degrees F).
  - 4) Permanently indicate the temperature settings near the associated signal light.
  - 5) When the coolant temperature drops to below 21 degrees C (70 degrees F), the "LOW COOLANT TEMPERATURE" signal light and the audible alarm shall be energized.
- c. Low Coolant Level: When the coolant level falls below the minimum level recommended by the manufacturer, the "low coolant level" signal light and audible alarm shall be energized.
- d. Lubricating Oil Pressure:
  - 1) When the pressure falls to the predetermined first stage level, the "OIL PRESSURE - FIRST STAGE" signal light and the audible alarm shall be energized.
  - 2) When the pressure falls to the predetermined second stage level, which shall be high enough to prevent damage to the engine and low enough to avoid unnecessary engine shutdowns, the "OIL PRESSURE - SECOND STAGE" signal light and the audible alarm shall be energized and the engine shall stop.
  - 3) Difference between the first and second stage pressure settings shall be approximately 15 percent of the oil pressure.
  - 4) Permanently indicate the pressure settings near the associated signal light.
- e. Overspeed:
  - 1) When the engine RPM exceeds the maximum RPM recommended by the manufacturer of the engine, the engine shall stop.
  - 2) Simultaneously, the "OVERSPEED" signal light and the audible alarm shall be energized.
- f. Low Fuel – Integral Belly Tank:
  - 1) When the fuel oil level in the fuel tank decreases to less than the level at which the fuel oil transfer pump should start to refill the tank, the "Low Fuel tank" light and the audible alarm shall be energized.
- g. Reset Alarms and Signals: Overcrank, Coolant Temperature, Coolant Level, Oil Pressure, Overspeed, and Low Fuel signal lights and the



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associated audible alarms shall require manual reset. A momentary-contact silencing switch and pushbutton shall silence the audible alarm by using relays of solid state devices to seal-in the audible alarm in the de-energized condition. Elimination of the alarm condition shall automatically release the sealed-in circuit for the audible so that it will be automatically energized again when the next alarm condition occurs. The signal lights shall require manual reset after elimination of the condition, which caused them to be energized. Install the audible alarm just outside the generator room in a location as directed by the Architect/Engineer. The audible alarm shall be rated for 85 dB at 3 meter (10 feet).

- h. Generator Breaker Signal Light:
  - 1) Molded case circuit breaker and contactor: A flashing green light shall be energized when the generator circuit breaker is in either the "open" or "tripped" position.
  - 2) Power circuit breaker: A flashing green light shall be energized when the generator circuit breaker is in the "open" or "tripped" position.
  - 3) Simultaneously, the audible alarm shall be energized.
- 4. Monitoring Devices:
  - a. Electric type gauges for the cooling water temperatures and lubricating oil pressures. These gauges may be engine mounted with proper vibration isolation.
  - b. A running time indicator, totalizing not less than a 9,999 hour, heavy duty and an electric type tachometer.
  - c. Voltmeter, ammeter, and their selector switches, frequency meter, kilowatt meter, manual adjusting knob for the output voltage and the other items shown on the drawings shall be mounted on the front of the generator control panels.
  - d. Install potential and current transformers as required.
  - e. Individual signal lights:
    - 1) OVER-CRANK
    - 2) HIGH COOLANT TEMPERATURE - FIRST STAGE
    - 3) HIGH COOLANT TEMPERATURE - SECOND STAGE
    - 4) LOW COOLANT TEMPERATURE
    - 5) OIL PRESSURE - FIRST STAGE
    - 6) OIL PRESSURE - SECOND STAGE
    - 7) LOW COOLANT LEVEL
    - 8) GENERATOR BREAKER
    - 9) OVERSPEED
    - 10) LOW FUEL - DAY TANK
    - 11) LOW FUEL – MAIN STORAGE TANK
  - f. Lamp Test: "Lamp Test" momentary contact switch shall momentarily actuate the alarm buzzer and all the indicating lamps.
- 5. Automatic Voltage Regulator:
  - a. Shall maintain the generator's output voltage within plus or minus one percent for load variations between no load and full load.



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- b. Shall correct voltage fluctuations rapidly and restore the output voltage to the predetermined level with a minimum amount of hunting.
  - c. Shall include voltage level rheostat located inside the control cubicle.
  - d. Provide a 3-phase automatic voltage regulator immune to waveform distortion when a UPS system is part of the load.
6. Governor: Specified herein before in Article 2.3 "GOVERNOR".
7. The voltage regulator and other components of the auxiliary electrical power system shall be protected during operation of the diesel engine-generator set at speeds other than the rated RPM while performing maintenance by a power monitoring system which monitors single phase and three phase faults. A time-delay relay shall shut down the engine when the alternator thermal capacity is exceeded.
8. Reverse Power Monitors: Solid-state reverse power monitors shall be furnished to sense motorizing of a failing engine-generator set. Upon detection of a reverse power flow, the monitor shall signal the alarm circuit for immediate power disconnect of the generator and actuation of load dumping circuits, and energize the audible and visual alarm signals. Monitors shall automatically reset open generator disconnect from the bus. An induction disc type reverse power relay with equivalent performance may be submitted for approval. The monitor shall have the following features:
- a. Accurate operation at power factors down to 0.2 lagging or leading.
  - b. Minimum 10 amperes output contacts rated at 480 volts.
  - c. Circuitry arranged to continually sense the output power of the generator for magnitude and direction.
  - d. Operate accurately over voltage range of 70 percent to 110 percent of rated voltage.
  - e. Adjustable dial for trip power range.
  - f. Test switch to simulate reverse power for periodic testing. Switch shall be arranged to cause sensing circuitry to measure a reverse power.

2.10 REMOTE ANNUNCIATOR PANEL

- A. Remote annunciator panel shall be installed at the Engineering Control Center.
- B. The annunciator shall indicate alarm conditions of the emergency or auxiliary power source as follows:
  - 1. Individual visual signals shall indicate:
    - a. Which generator is operating to supply power to load?
    - b. Which battery charger is malfunctioning?
    - c. When main storage tank is low.
  - 2. Individual visual signals plus a common audible alarm shall warn of the following:
    - a. "Low lubricating oil pressure - FIRST STAGE."
    - b. "Low coolant."
    - c. "Excessive coolant temperature - FIRST STAGE."
    - d. Low fuel - day tank."



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- e. "Overcrank" (failure to start).
- f. "Overspeed."

C. The annunciator shall also have the following features:

- 1. One pushbutton momentary contact switch. Label switch "LAMP - TEST". Initiating this switch shall momentarily actuate the alarm buzzer and all the indicating lamps.
- 2. Audible Alarm: There shall be an audible alarm, rated for 85 dB at 10 feet, which shall become actuated whenever an alarm condition occurs. A momentary-contact acknowledge pushbutton shall silence the audible alarm, but not clear the alarm lamp. Elimination of the alarm condition shall automatically release the seal-in circuit for the audible alarm and extinguish the alarm lamp.

## 2.11 REMOTE MONITORING PANEL

- A. Shall have duplicates of the voltmeter, ammeter, and voltmeter and ammeter selector switches, engine running light (red) and shall be located at the Engineering Control Center. Install circuits between the Remote Monitoring panel and the Engine-Generator Control Cubicle. //

## 2.12 SOUND ATTENUATED ENCLOSURE

- A. The emergency generator set and related equipment shall be housed in an outdoor weatherproof enclosure. The generator will function properly without overheating in the ambient conditions specified. Enclosure shall be weatherproof and sound attenuated (maximum 85 dBA at 1525 mm (five feet) from any side, top and bottom to no more than 75 dBA when measured at 15 meters (50 feet) horizontally from any part of the enclosure) Sound ratings shall be based on full load condition of engine/generator in a single unit operation condition. Airflow configuration of the unit will be intake through rear of unit and discharge air vertically up. Enclosure shall be suitable for winds up to 193 kmh (120 mph); roof load shall be equal to or greater than 200 kg/sq m (40 lbs per sq. ft). Non-distributed loading as required. If Tier 4 equipment is monted to roof, then the rood load shall be equal to the equipment load plus 40lb per sq ft.
- B. The enclosure shall meet the following requirements:
  - 1. The exterior finish shall be guaranteed for a period of 10 years to be free from any defects when properly maintained.
  - 2. Radiator exhaust outlet shall be ducted through the end of the enclosure.
  - 3. All exterior surfaces shall be factory painted with industrial enamel.
  - 4. Unit shall have sufficient guards to prevent entrance by small animals.
  - 5. Batteries to fit inside enclosure and along side the engine provide protective shield. (Batteries under the generator are not acceptable.)
  - 6. Exhaust System: The silencer shall be critical grade, mounted and thermally insulated inside the enclosure. Insulation must be provided for the silencer, flex and all discharge piping. The weight of the silencer shall not be supported by



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engine. The exhaust pipe size shall be sufficient to insure that exhaust backpressure does not exceed the maximum limitations specified by the engine manufacturer. The exhaust silencer outlet roof penetration shall be sealed to prevent the entrance of rain, snow and sleet. A stainless steel bellowed flex shall be provided.

## 2.13 SPARE PARTS

- A. For each engine-generator set:
  - 1. Six lubricating oil filters.
  - 2. Six primary fuel oil filters.
  - 3. Six secondary fuel oil filters.
  - 4. Six intake air filters.
- B. For battery charger:
  - 1. Three complete sets of fuses.
  - 2. One complete set of indicating lamps.
- C. For control and supervisory panel:
  - 1. Three complete sets of fuses.
  - 2. One complete set of indicating lamps.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install concrete bases of dimensions shown on the drawings for packaged engine-generator sets.
- B. Installation of the engine generator set shall comply with manufacturer's written instructions and with NFPA 110.
- C. Mounting
  - 1. Support the base of engine-generator set on vibration isolators, each isolator bolted to the floor (pad), generator base bolted to isolator.
  - 2. Install sufficient number of isolators so that the floor (pad) bearing pressure under each isolator is within the floor (pad) loading specification.
  - 3. Install equal number of isolators on each side of the engine-generator set's base.
  - 4. Locate isolators for approximately equal load distribution and deflection per isolator. Base of the engine-generator set shall be drilled at the factory for the isolator bolts.
  - 5. Isolators shall be shipped loose with the engine-generator set.



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6. All connections between the engine-generator set and exterior systems, such as fuel lines, electrical connections, and engine exhaust system and air exhaust shroud, shall be flexible.

D. Balance:

1. The vibration velocity in the horizontal, vertical, and axial directions shall not exceed 16.25 mm (0.65 inch) per second peak at any specific frequency. These limits apply to main structural components such as the engine block and the generator frame at the bearings.
2. Balance the engine-generator set statically and dynamically at the factory in order to comply with the maximum specified vibration velocity.

- E. Connect all components of the essential electrical power system so that they will continue to be energized by the auxiliary electrical power system during failures of the normal electrical power supply system.

- F. Install piping between diesel engine and remote components of cooling, fuel and exhaust systems.

G. Flexible connection between radiator and exhaust shroud at the wall damper:

1. Install noncombustible flexible connections made of 20-ounce neoprene-coated fiberglass fabric approximately 150 mm (six inches) wide.
2. Crimp and fasten the fabric to the sheet metal with screws 50 mm (two inch) on center. The fabric shall not be stressed, except by the air pressure.

H. Exhaust System Insulation:

1. Adhesive and insulation materials shall be applied on clean, dry surfaces from which loose scale, and construction debris has been removed by wire brushing.
2. Fill all cracks, voids and joints of applied insulation material with high temperature 1093 degrees C (2000 degrees F) insulating cement before applying the outer covering.
3. The installation shall be neat, thermally and structurally tight without sag, neatly finished at all hangers or other penetrations and shall provide a smooth finish surface.
4. Insulation and jacket shall terminate hard and tight at all anchor points.
5. Insulate completely from engine exhaust flexible connection through roof or wall construction, including muffler.

### 3.2 START UP AND TESTING

- A. Provide the services of a factory-authorized, factory-trained representative of the diesel engine-generator set manufacturer to inspect field-assembled components, and equipment installation and supervise the field tests



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- B. When the complete auxiliary electrical power system has been installed and prior to the final inspection, tests all components of the system in the presence of the Architect/Engineer for proper operation of the individual components and the complete system and to eliminate electrical and mechanical defects.
- C. Furnish fuel oil, lubricating oil, anti-freeze liquid, water treatment and rust inhibitor and load bank for testing of the diesel engine-generator set.
- D. Field Tests for the Diesel Engine-Generator Set in accordance with NFPA 110 and manufacturer requirements:
  - 1. Visual and mechanical inspection:
    - a. Compare equipment nameplate with drawings and specifications.
    - b. Inspect physical and mechanical condition.
    - c. Inspect correct anchorage and grounding.
  - 2. Electrical and Mechanical tests:
    - a. Perform insulation-resistance test on generator winding with respect to ground in accordance with ANSI/IEEE Standard 43.. Calculate polarization index.
    - b. Test protective relay devices in accordance with NETA requirements.
    - c. Perform phase-rotation test to determine compatibility with load requirements.
    - d. Functionally, test engine shutdown for low oil pressure, over temperature, over speed, and other features as applicable.
    - e. Verify correct functioning of governor and regulator.
  - 3. Test values:
    - a. Polarization index values shall be in accordance with IEEE Standard 43.
    - b. Performance tests shall conform to manufacturer's published data
  - 4. Test the engine generator set for eight hours of continuous operation as follows:
    - a. First hour while the set is delivering 40 percent of its specified KW rating with a 10% step increase every hour to 90% of its specified kW rating.
    - b. Last two hours while the set is delivering 100 percent of its specified KW rating.
    - c. If during the 8-hour continuous test a failure occurs, either the diesel engine shuts down or the full KW rating of the load bank is not achieved, the test is null and void. The test(s) shall be repeated until the satisfactory results are attained at no additional cost to the government.
  - 5. Record the following test data at 30-minute intervals:
    - a. Time of day, also reading of running time indicator.
    - b. KW.
    - c. Voltage on each phase.
    - d. Amperes on each phase.
    - e. Engine RPM.
    - f. Frequency.
    - g. Engine water temperature.



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- h. Fuel pressure
  - i. Oil pressure.
  - j. Outdoor temperature
  - k. Average ambient temperature in the vicinity of the diesel engine.
  - l. Average ambient temperature in the vicinity of the starting batteries.
- 6. Demonstrate that the generator set will attain proper voltage, frequency and will accept 100 percent block load within 10 seconds from a cold start after the closing of a single contact.
- 7. Furnish a resistance type load for the testing of the generator:
  - a. When approved in writing by the Architect/Engineer prior to the testing, the Contractor may use connected loads in the building (resistant plus other types) as part of the test load provided the Contractor assumes complete responsibility for the use of the connected loads, including personnel injuries and property damage.
  - b. Test loads shall always include adequate resistance to assure stability of the loads and equipment during all of the testing operations. The test load KW rating:
    - 1) Shall not be less than 100 percent of the specified KW rating of the largest generator set.
    - 2) Shall not be less than 35 percent of the sum of the specified KW ratings of the all generator sets in a paralleling system.
- E. Battery and Starting System Test:
  - 1. Demonstrate that the batteries and cranking motor are capable of 5 starting attempts of 10 second cranking each at 10 second intervals with the battery charger turned off.
- F. Test local and remote panels: Simulate engine failures while checking for proper operation of each indicating lamp, alarm device and reset button. (It is recommended that one technician be located in the generator room and another at the site of remote panels. By means of telephone or walkie-talkies, the technicians should be assured of proper operation and coordination of these panels.)
- G. At the completion of the field tests, fill the underground storage tank with fuel of grade and quality as recommended by the manufacturer of the engine.
- H. When any defects are detected during the tests, correct all the deficiencies and repeat all or part of the 8-hour continuous test as requested by the Architect/Engineer, at no additional cost to the Government.
- I. Provide test and inspection results in writing to the Architect/Engineer.



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**3.3 INSTRUCTIONS AND FINAL INSPECTIONS**

- A. Laminate or mount under Plexiglas a set of operating instructions for the system and install instructions within a frame mounted on the wall near the diesel engine-generator set as requested by the Architect/Engineer.
- B. At the final inspection in the presence of a Owner representative, demonstrate that the complete auxiliary electrical power system operates properly in every respect.
- C. Furnish the services of a competent, factory-trained engineer or technician for five, 4-hour periods for instructions to Owner personnel in operation and maintenance of the equipment, on the dates requested by the Architect/Engineer. Submit factory training plan outline to Owner for review and approval.

**END OF SECTION**



## **SECTION 26 36 00 - AUTOMATIC TRANSFER SWITCH**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Automatic transfer switch rated 600V and less.

#### **1.2 1SUBMITTALS**

- A. Product Data: Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
- C. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- D. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- E. Dimensioned Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- F. Detailed description of equipment anchorage devices on which the certification is based.
- G. Field quality-control test reports.
- H. Operation and maintenance data.

#### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.



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- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 70.
- D. Comply with NFPA 99.
- E. Comply with NFPA 110.
- F. Comply with UL 1008 unless requirements of these Specifications are stricter.

## PART 2 - PRODUCTS

### 2.1 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Contactor Type Transfer Switch:
    - a. Russelectric
    - b. ASCO
- C. Approved generator manufacturer's standard unit.

### 2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
  - 1. 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE



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C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
  - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
  - 2. Switch Action: Double throw; mechanically held in both directions.
- G. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- H. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- I. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- J. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
- K. Battery Charger: For generator starting batteries.
  - 1. Float type rated 10 A.
  - 2. Ammeter to display charging current.
  - 3. Fused ac inputs and dc outputs.
- L. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

## 2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- D. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.



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- E. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase.
- F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated.
- G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer.
- H. Automatic Transfer-Switch Features:
  - 1. Under voltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
  - 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
  - 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
  - 4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained under voltage of emergency source, provided normal supply has been restored.
  - 5. Test Switch: Simulate normal-source failure.
  - 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
  - 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    - b. Available."
    - c. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
  - 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
  - 9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
  - 10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
  - 11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.



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12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5minute cool-down period. Exerciser features include the following:
  - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
  - b. Push-button programming control with digital display of settings.
  - c. Integral battery operation of time switch when normal control power is not available.

## 2.4 SOURCE QUALITY CONTROL

- A. A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details.
- B. Floor-Mounting Switch: Anchor to floor by bolting.
  1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 16 Section "Hangers and Supports for Electrical Systems."
- C. Identify components according to section "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.



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3.2 CONNECTIONS

- A. Ground equipment according to Division 16 Section 16170 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 16 Section 16123 "Electrical Wire and Cables."

3.3 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
  - 2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation resistance tester. Use test voltages and procedure recommended by manufacturer.
    - a. Comply with manufacturer's specified minimum resistance.
    - b. Check for electrical continuity of circuits and for short circuits.
    - c. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    - d. Verify that manual transfer warnings are properly placed.
    - e. Perform manual transfer operation.
  - 5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    - c. Verify time-delay settings.
    - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
    - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cooldown and shutdown.



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- 6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
- C. Coordinate tests with tests of generator and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- E. Remove and replace malfunctioning units and retest as specified above.
- F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
  - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
  - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."
- B. Coordinate this training with that for generator equipment.

**END OF SECTION**



## SECTION 26 36 00 - TRANSFER SWITCHES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Contactor-type automatic transfer switches.
2. Bypass/Isolation automatic transfer switches.
3. Nonautomatic temporary generator transfer switches
4. Remote annunciator systems.
5. Remote annunciation and control systems
6. Transfer switch accessories.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification, available on a 7x24x365 call basis.
- B. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches nonautomatic temporary generator transfer switches remote annunciators and remote annunciator and control panels through one source from a single manufacturer.

#### 1.3 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
1. Warranty Period: **18 months** from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 110.
- B. Comply with UL 1008 unless requirements of these Specifications are stricter.



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- C. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- D. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
  - 1. Short-time withstand capability for 30 cycles.
- E. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- F. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- G. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.
- H. Generator Control Wiring Integrity: As required by NEC Article 700.10(D)(3), provide means for continuously ensuring the integrity of the control wiring between the transfer switch and its associated generator(s), including the action to automatically start the generator(s) upon circuit malfunction and alarming this condition remotely. Coordinate with generator set and paralleling switchgear manufacturers.
- I. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- J. Neutral Terminal: Solid and fully rated unless otherwise indicated.
- K. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
- L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- M. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed shrinkable sleeve markers at terminations. Color-coding and wire and cable markers are specified in Section 26 05 53 "Identification for Electrical Systems."
  - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.



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2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
  3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
  4. Accessible via front access.
- N. Enclosures: General-purpose NEMA 250, Type 1 for indoor locations and Type 4X for outdoor locations, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.
- O. Provide infrared transparent viewing windows rated for the available fault current conditions to allow inspection of transfer switch and bypass/isolation switch compartment power circuit connections without requiring the opening of the compartment.

## 2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kohler Power Systems.
  2. Automatic Switch Company (ASCO), a Division of Schneider Electric.
  3. ABB, Electrification Products Division.
  4. Caterpillar, Inc.; Electric Power Division.
  5. Cummins Power Generation.
  6. Eaton.
  7. Emerson.
  8. Hubbell Incorporated, Power Systems.
  - 9.
  10. MTU America Inc.
- B. Comply with Level 1 equipment according to NFPA 110.
- C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
  2. Switch Action: Double throw; mechanically held in both directions.
  3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
  4. Conductor Connectors: Suitable for use with conductor material and sizes.
  5. Material: Hard-drawn copper, 98 percent conductivity.
  6. Main and Neutral Lugs: Mechanical type.
  7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
  8. Ground bar.
  9. Connectors shall be marked for conductor size and type according to UL 1008.



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- D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
  - 1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
- E. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.
  - 1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
  - 2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
  - 3. Fully automatic break-before-make operation with center off position.
  - 4. Fully automatic break-before-make operation with transfer when two sources have near zero phase difference.
- F. Manual Switch Operation, Non-Load-Breaking: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- G. Electric Nonautomatic Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.
- H. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.
- I. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- J. Automatic Transfer-Switch Controller Features:
  - 1. Controller operates through a period of loss of control power.
  - 2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
  - 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
  - 4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss



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of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
  - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
  - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum. See paragraph 2.1.H. for additional requirements.
11. Engine Shutdown Contacts:
  - a. Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
  - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
  - b. Push-button programming control with digital display of settings.
  - c. Integral battery operation of time switch when normal control power is unavailable.

K. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to



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motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.

3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

## 2.3 NONAUTOMATIC TEMPORARY GENERATOR TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. ASCO Power Technologies, a Division of Schneider Electric.
  2. Caterpillar, Inc.; Electric Power Division.
  3. Eaton.
  4. ABB, Electrification Products Division.
  5. Russelectric, Inc.
- B. Manually Operated: Mechanically interlocked switch shall be capable of manually transferring Emergency Power System load between the permanently installed engine-generator set and a temporary replacement source, operation shall be unloaded. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.
- C. Pilot Lights: Indicate source to which load is connected.
- D. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternative-source sensing circuits.
  1. Normal Generator Supervision: Green light with nameplate engraved "Normal Generator Available."
  2. Temporary Power Supervision: Red light with nameplate engraved "Alternative Source Available."
- E. Alarm Contacts: Switch shall have two (2) sets of normally open contacts for each switch position for remote annunciation of the permanent emergency source is disconnected from the emergency system. Contacts to be rated 10 A at 240-V ac
- F. Unassigned Auxiliary Contacts: Switch shall have one set of normally closed contacts for each switch position, rated 10 A at 240-V ac.
- G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.



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1. Switch Action: Double throw; mechanically held in both directions.
2. Contacts: Silver composition or silver alloy for load-current switching.
3. Conductor Connectors: Suitable for use with conductor material and sizes.
4. Material: Hard-drawn copper, 98 percent conductivity.
5. Main and Neutral Lugs: Mechanical type.
6. Ground Lugs and Bus-Configured Terminators: Mechanical type.
7. Ground bar.
8. Connectors shall be marked for conductor size and type according to UL 1008.
9. Provide cam-lock connections in the quantities required to carry the full load of the permanently installed engine generator set. Connectors shall be labeled to indicate the required system phase rotation and bonding requirements and shall be located behind a lockable outer door which allows the temporary cables to exit unimpeded.
10. Switch shall have provisions for conveying the automatic start and stop signals to the temporary unit using the same protocol as the permanently installed generator set.

## 2.4 TRANSFER SWITCH ACCESSORIES

### A. Bypass/Isolation Switches:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
  - a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.
  - b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
  - c. Draw-out Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations. Transfer switch and bypass/isolation switch shall be in isolated compartments.
  - d. Transition:
    - 1) Provide closed-transition operation when transferring from main transfer switch to bypass/isolation switch on the same power source.
    - 2) Provide open -transition operation when transferring between power sources.
  - e. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.



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- f. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
  - g. Manual Control: Constructed so load bypass and transfer-switch isolation can be performed by one person in no more than two operations in 15 seconds or less. Operating handles shall be externally operated.
  - h. Automatic and Nonautomatic Control: Automatic transfer-switch controller shall also control the bypass/isolation switch.
  - i. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
  - j. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.
4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

B. Remote Annunciator System:

- 1. Source Limitations: Same manufacturer as transfer switch in which installed.
- 2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
- 3. Annunciation panel display shall include the following indicators:
  - a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
  - b. Switch position.
  - c. Switch in test mode.
  - d. Generator start circuit malfunction.
  - e. Failure of communication link.
- 4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
  - a. Indicating Lights: Grouped for each transfer switch monitored.
  - b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
  - c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
  - d. Lamp Test: Push-to-test or lamp-test switch on front panel.

C. Remote Annunciator and Control System:

- 1. Source Limitations: Same manufacturer as transfer switch in which installed.
- 2. Include the following functions for indicated transfer switches:
  - a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
  - b. Indication of switch position.
  - c. Indication of switch in test mode.
  - d. Indication of generator remote control circuit malfunction
  - e. Indication of failure of digital communication link.
  - f. Key-switch or user-code access to control functions of panel.
  - g. Control of switch-test initiation.
  - h. Control of switch operation in either direction.



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- i. Control of time-delay bypass for transfer to normal source.
- 3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
- 4. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
  - a. Controls and indicating lights grouped together for each transfer switch.
  - b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
  - c. Digital Communication Capability: Matched to that of transfer switches supervised.
  - d. Mounting: Flush, modular, steel cabinet unless otherwise indicated.

## 2.5 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.
- B. Prepare test and inspection reports.
  - 1. For each of the tests required by UL 1008, performed on representative devices, for emergency and legally required systems. Include results of test for the following conditions:
    - a. Overvoltage.
    - b. Undervoltage.
    - c. Loss of supply voltage.
    - d. Reduction of supply voltage.
    - e. Alternative supply voltage or frequency is at minimum acceptable values.
    - f. Temperature rise.
    - g. Dielectric voltage-withstand; before and after short-circuit test.
    - h. Overload.
    - i. Contact opening.
    - j. Endurance.
    - k. Short circuit.
    - l. Short-time current capability.
    - m. Dielectric withstand capability.
    - n. Insulating base and supports damage.



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PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Administrant for Tests and Inspections:

1. Owner will engage qualified testing agency to administer and perform tests and inspections.
2. Engage qualified testing agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections

B. Tests and Inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:
  - a. Compare equipment nameplate data with Drawings and Specifications.
  - b. Inspect physical and mechanical condition.
  - c. Inspect anchorage, alignment, grounding, and required clearances.
  - d. Verify that the unit is clean.
  - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
  - f. Verify that manual transfer warnings are attached and visible.
  - g. Verify tightness of all control connections.
  - h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
    - 1) Use of low-resistance ohmmeter.
    - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
  - i. Perform manual transfer operation.
  - j. Verify positive mechanical interlocking between normal and alternate sources.
  - k. Perform visual and mechanical inspection of surge arresters.
  - l. Inspect control power transformers.
    - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
    - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
    - 3) Verify correct functioning of draw-out disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:



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- a. Perform insulation-resistance tests on all control wiring with respect to ground.
  - b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
  - c. Verify settings and operation of control devices.
  - d. Calibrate and set all relays and timers.
  - e. Verify phase rotation, phasing, and synchronized operation.
  - f. Perform automatic transfer tests.
  - g. Verify correct operation and timing of the following functions:
    - 1) Normal source voltage-sensing and frequency-sensing relays.
    - 2) Engine start sequence.
    - 3) Time delay on transfer.
    - 4) Alternative source voltage-sensing and frequency-sensing relays.
    - 5) Automatic transfer operation.
    - 6) Interlocks and limit switch function.
    - 7) Time delay and retransfer on normal power restoration.
    - 8) Engine cool-down and shutdown feature.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
- a. Check for electrical continuity of circuits and for short circuits.
  - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
  - c. Verify that manual transfer warnings are properly placed.
  - d. Perform manual transfer operation.
5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
- a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
  - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
  - c. Verify time-delay settings.
  - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
  - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
  - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microohms and values for one pole deviating by more than 50 percent from other poles.
  - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- C. Coordinate tests with tests of generator and run them concurrently.



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- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- E. Transfer switches will be considered defective if they do not pass tests and inspections.
- F. Remove and replace malfunctioning units and retest as specified above.
- G. Prepare test and inspection reports.
- H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner if installed infrared viewing windows are not adequate to view all connections.
  - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.2 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
- B. Coordinate this training with that for generator equipment.

**END OF SECTION 26 36 00**



## **SECTION 26 51 13 - LIGHTING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Interior lighting fixtures, lamps, electronics and accessories.
  - 2. Exterior lighting fixtures, poles and accessories.
  - 3. Exit signs.
  - 4. Lighting fixture supports.

#### **1.3 DEFINITIONS**

- A. BUG: Backlight, Uplight and Glare.
- B. CCT: Correlated color temperature.
- C. CP: Chicago Plenum.
- D. CRI: Color-rendering index.
- E. CU: Coefficient of utilization.
- F. IP: International Protection or Ingress Protection Rating.
- G. LED: Light Emitting Diode.
- H. LER: Luminaire efficacy rating.
- I. Luminaire: Complete lighting fixture, including ballast housing if provided.
- J. RCR: Room cavity ratio.

#### **1.4 SUBMITTALS**

- A. Submit under provisions of Division 01 Section 01 33 00.



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- B. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
1. Physical description of lighting fixture including dimensions.
  2. Accessories including power supplies, mounting brackets or arms, poles, lenses, and mounting channels.
  3. Emergency lighting units including battery and charger.
  4. LED power supply or driver.
  5. Dimming arrangement or type and dimmer compatibility with specified systems.
  6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project IES LM-79 and IES LM-80.
  7. Energy-efficiency data.
  8. BUG ratings for exterior luminaires.
  9. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design
  10. Energy Star and/or DLC listing or certifications.
  11. Lamps: as applicable, provide separate list, keyed to fixture type, indicating manufacturer, catalog number, voltage, color temperature, life, output, and energy-efficient data.
- C. Product Lead Time: Provide manufacturer's lead times for all luminaires.
- D. Product Unit Pricing: Provide distributor net, unit pricing for each luminaire type and lamp type.
- E. Shop Drawings: Show details of nonstandard or custom lighting fixtures including all linear LED products and pole mounted Apron Lighting. Indicate dimensions, weights, methods of field assembly, components, remote power supplies/drivers, features, and accessories.
1. Wiring Diagrams: Power and control wiring, control devices and drivers for LED systems with remote power supplies.
- F. Product Certificates: For each type of ballast or LED driver for dimmer-controlled fixtures, signed by product manufacturer. (LM-79 and LM-80 Data)
- G. Qualification Data: For agencies providing photometric data for lighting fixtures.
- H. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
- I. Warranties: Special warranties specified in this Section.



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1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. Structural Analysis Criteria for Pole Selections
  - 1. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.
  - 2. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4.
  - 3. Ice Load: Load of 3 lbf/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-4.
  - 4. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
    - a. Wind speed for calculating wind load for poles is 90 MPH.
- E. The lighting fixtures for this project have been specified to accommodate specific aesthetic considerations, owner's requirements, illumination performance, budgetary criteria, and energy use performance. These requirements and the lighting fixtures specified have been carefully researched and coordinated with the various disciplines of the design team. Substitutions to the specified fixtures may cause delays to the project schedule to accommodate review and acceptance. Alternate products if desired must be proposed and coordinated between the design and contracting trade partner during the design development phase of the project. The following are conditions that must be met to accept alternate products:
  - 1. Any substitutions must be reviewed by design team for acceptance with standards, quality and maintenance concerns.
  - 2. All substitutions must identify specific benefit to the owner or project including illumination performance, constructability, availability, warranties or cost savings.
  - 3. All substitutions shall demonstrate illumination and energy performance that matches or exceeds the specified product.
  - 4. Substitutions offered during the construction phase will not be considered unless there is a compelling reason or value to the project. This could include products that have been discontinued, changes to manufacturer's data and schedule or lead time benefits.



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1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including clean room ceiling systems, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate dimensions of lighting fixtures to be installed inside ceiling coves and pockets with other trades including drywall and framing. There are details located within the architectural and interior design drawings that identify lighting scope.
- C. Coordinate the installation of luminaires and associated lighting control and dimming system or devices. Demonstrate to Owner and Architect a complete and functional lighting system that operates as designed at project closeout.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Emergency Power Supplies and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.
- B. Special Warranty for LED Drivers: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace drivers and power supplies that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Electronic LED Drivers or Power Supplies: Five years from date of Substantial Completion.
- C. Special Warranty for LED lamp/light engines: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps, or complete fixtures if necessary, that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
  - 1. Warranty Period: Five year(s) from date of Substantial Completion.
- D. Special Warranty for Lighting Poles and Brackets: Manufacturer's standard form, made out to Owner and signed by pole manufacturer agreeing to replace poles and brackets, that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
  - 1. Warranty Period for metal corrosion and color retention on lighting poles and brackets: Five years from date of Substantial Completion.



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PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Furnish products as specified in this Section and in Luminaire Schedule on Drawings:
1. The lighting design is based on the performance and aesthetics of the lighting fixtures named in the Luminaire Schedule on the drawings. Provide product from one of the manufacturer's listed in Luminaire Schedule.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- E. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated
1. White Surfaces: 85 percent.
  2. Specular Surfaces: 83 percent.
  3. Diffusing Specular Surfaces: 75 percent.
  4. Laminated Silver Metallized Film: 90 percent.
- F. Plastic Diffusers, Covers, and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
    - b. UV stabilized.
  2. Glass: Annealed crystal glass, unless otherwise indicated.
- G. Factory Applied Labels
1. Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen



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from normal viewing angles when lamps are in place. Label shall include following lamp and ballast characteristics:

- a. "USE ONLY" and include specific lamp type.
- b. Lamp diameter or shape code (A/T/MR PAR, etc.).
- c. CCT and CRI for all luminaires.

2.3 SOLID STATE LIGHTING / LIGHT EMITTING DIODE (LED) LAMPS AND LUMINAIRES

A. General:

1. Luminaire manufacturer shall have a minimum of five (5) years experience in the manufacture and design of LED products and systems and no less than one hundred (100) North American installations.
2. Unless otherwise specified, all LED luminaires and power/data supplies shall be provided by a single manufacturer to ensure compatibility.
3. All components, peripheral devices and control software are to be provided by and shall be the responsibility of a single entity. All components shall perform successfully as a complete system.
4. Include all components necessary for a complete installation. Provide all power supplies, synchronizers, data cables, and data terminators for a complete working system.
5. All LED sources used in the LED luminaire shall be of proven quality from established and reputable LED manufacturers and shall have been fabricated after 2015. Acceptable LED lamp manufacturers unless otherwise noted are:
  - a. Cree, Inc.
  - b. Citizen
  - c. Philips Lighting
  - d. Nichia Corporation
  - e. Norlux
  - f. Opto Technology, Inc.
  - g. Osram Optronic Semiconductors
  - h. Xicato

B. Replacement and Spares:

1. Manufacturer shall provide written guarantee of the following:
  - a. Manufacturer will keep record of original bin for each LED module and have replacement modules from the same bin available for three (3) years after date of installation.
  - b. Manufacturer will keep an inventory of replacement parts (source assembly, power and control components).
  - c. Manufacturer's LED system will not become obsolete for ten (10) years: Manufacturer will provide exact replacement parts or provide upgraded parts that are designed to fit into the original luminaire and provide equivalent distribution and lumen output to the original, without any negative consequences.



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2. All parts of system shall be replaceable in field. Manufacturer shall provide written guarantee of the following:
  - a. Manufacturer has in place a written recycling and re-use program and will accept returned product and/or components for recycling or re-use.
  - b. Manufacturer will properly dispose of non-recyclable components that are deemed harmful to the environment.
3. System shall carry a full warranty for five (5) years. Manufacturer shall be responsible for cost of labor not to exceed \$50 per individual part, and cost of shipping, to replace any component of the system that fails within 2 years of installation.

C. Products and Components – Performance:

1. LED luminaires and components shall be UL listed or UL classified.
2. All LED luminaires shall be subjected to the following JEDEC Reliability Tests for Lead-free Semiconductors: HTOL, RTOL, LTOL, PTMCL, TMSK, Mechanical Shock, Variable Vibration Frequency, SHR, Autoclave.
3. To ensure luminaire quality, luminaire shall have been tested under accelerated life test conditions including an operating temperature span of 360 degrees F, and cyclic loading up to 60G.
4. All LED components shall be mercury and lead-free.
5. All manufacturing processes and materials shall conform to the requirements of the European Union's Restriction on the Use of Hazardous Substances in Electrical and Electronics Equipment (RoHS) Directive, 2002/95/EC.
6. LEDs shall comply with ANSI/NEMA/ANSI C78.377-2008 – Specifications for the Chromaticity of Solid State Lighting Products. Color shall remain stable throughout the life of the lamp. Color shall match approved sample.
7. LEDs shall comply with IESNA LM-80 – Standards for Lumen Maintenance of LED Lighting Products
8. White LEDs shall have a rated source life of 50,000 hours under normal operating conditions. RGB LEDs shall have a rated source life of 100,000 hours. LED “rated source life” is defined as the time when a minimum of 70% of initial lumen output remains.
9. Luminaire assembly shall include a method of dissipating heat so as to not degrade life of source, electronic equipment, or lenses. LED luminaire housing shall be designed to transfer heat from the LED board to the outside environment. Luminaire housing shall have no negative impact on life of components.
10. Manufacturer shall supply in writing a range of permissible operating temperatures in which system will perform optimally.
11. High power LED luminaires shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware
12. LEDs shall be adequately protected from moisture or dust in interior applications.
13. For wet and damp use, LED-based luminaires itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure. Such protection shall have no negative impact



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- on rated life of source or components, or if so, such reductions shall be explicitly brought to the attention of the designer.
14. All hardwired connections to LED luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
  15. The LED luminaire shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.
  16. RGB LED luminaires shall utilize an equal combination of high brightness red, blue and green LEDs, unless otherwise noted, to provide up to 16.7 million additive RGB colors and shall be capable of at least 8-bit control.
  17. Manufacturer shall be able to provide supporting documentation of the product meeting third party regulatory compliance.
  18. Manufacturer shall ensure that products undergo and successfully meet appropriate design and manufacturability testing including Design FMEA, Process FMEA, Environmental Engineering Considerations and Laboratory Tests, IEC standards and UL/CE testing.
  19. All LED luminaires (100% of each lot) shall undergo a minimum twenty-four (24) hour burn-in during manufacturing, prior to shipping.
  20. Manufacturer shall provide Luminaire Efficacy (lm/W), total luminous flux (lumens), luminous intensity (candelas) chromaticity coordinates, CCT and CRI. Optical performance, polar diagrams, and relevant luminance and illuminance photometric data. Provide data in IES file format in accordance with IES LM-79-2008, based on test results from an independent Nationally Recognized Testing Laboratory.
  21. Power / data supply shall have the following:
    - a. Supply outputs shall have current limiting protection.
    - b. Supply shall provide miswiring protection.
    - c. Supply shall have power factor correction.
    - d. Supply shall provide connections that are conduit-ready or clamp-style connections in the case of low-voltage wiring.
    - e. Supply shall come with a housing that meets a minimum IP20 rating for dry location installation unless located in a damp or wet location.
    - f. Supply shall be UL listed for Class 1 or Class 2 wiring.

## 2.4 EXTERIOR LUMINAIRES

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.



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D. Diffusers and Lenses:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed borosilicate, crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

## 2.5 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finishes process and color of pole or support materials.
- C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.



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3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
  4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
    - a. Color: as indicated on drawings, fixture schedule.
- D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
  2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - a. Color: As selected from manufacturer's standard catalog of colors.

## 2.6 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
  2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
1. Materials: Shall not cause galvanic action at contact points.
  2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
  3. Anchor-Bolt Template: Plywood or steel.
- D. Handhole: Oval-shaped, with minimum clear opening of 2 ½ by 5 inches, with cover secured by stainless steel captive screws.



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- E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.7 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in height with access handhole in pole wall.
  - 1. Shape: Round, straight.
  - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Steel Mast Arms: Continuously welded to pole attachment plate. Material and finish same as pole.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
  - 1. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
  - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
  - 3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- F. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- G. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.
- H. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- I. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.



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- J. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
  2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
  3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - a. Color: Match Architect's sample [As selected by Architect from manufacturer's full range].

2.8 ALUMINUM POLES

- A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.
- B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
1. Shape: Round, straight.
  2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
  2. Finish: Same as pole.
- F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- G. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.



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2.9 POLE ACCESSORIES

- A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 26 Section "Wiring Devices" for ground-fault circuit-interrupter type.
  - 1. Recessed, 12 inches above finished grade.
  - 2. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, that when mounted results in NEMA 250, Type 3R enclosure.
  - 3. With cord opening.
  - 4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
- B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.
- C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

2.10 EXIT SIGNS

- A. Description: Comply with UL 924; for visibility, luminance, and lettering size, comply with authorities having jurisdiction. Sign color shall be green to match existing facility. Verify mounting requirements of all sign locations prior to installation and ordering.
- B. Internally Lighted Signs:
  - 1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
  - 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    - f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
    - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.



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2.11 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- H. Individual fixtures shall carry weight of fixture to building construction, clear of ducts or pipes.
- I. Provide recessed LED luminaires with structural members and leveling provisions.
- J. Provide pendant-mounted fixtures with conduit stems supported to ceiling framework with self-leveling fittings.
- K. All pendant mounted fixtures to contain swivel connector at canopy at plane of suspended ceiling. Pendant mounted fixtures installed in areas without suspended ceilings must be provided with flexible connection at structure to allow for lateral movement.
- L. Provide minimum of 4 earthquake clips for recessed lighting fixtures installed in ceilings which meets Seismic Zone 2A requirements. Fixtures not installed in this type of ceiling must be independently hung from 4 points and cable braced to the deck.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.



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1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
  2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
  3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
  4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Coordinate installation of lighting fixtures in custom ceiling coves and pockets.
- D. Coordinate installation of lighting fixtures in clean room ceiling systems.
- E. Suspended Lighting Fixture Support:
1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  2. Aircraft cable: Luminaire manufacturer's field adjustable cable assembly set to elevations indicated on drawings.
  3. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
- F. Adjust aimable lighting fixtures as directed by Lighting Designer to provide required light intensities.
1. Target and focus after regular working hours and before building acceptance.
  2. Permanently indicate targeting on fixture and provide positive locking devices to preclude mis-focus during relamping.
  3. Target and focus in the presence of the Architect and Lighting Designer.
- G. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- H. Connect luminaires to occupancy and daylight controls under provisions of Division 26 Section "Central Dimming Controls".
- I. Provide additional dimming control wiring as necessary for luminaires furnished with 0-10volt dimming. Existing branch circuit wiring may be re-used, however additional control wiring will be required for 0-10 volt dimming circuits.
- J. Locations:
1. Locations on the drawings are diagrammatic. Verify exact locations with architectural reflected ceiling drawings and coordinate space conditions with other trades.
  2. Fixture rows shall be in straight lines except as noted. Fixture doors shall open from same side.
  3. Pendant or surface mounting height shall be as noted.



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4. For speakers or air diffusers where indicated in common and continuous rows with lighting fixtures, provide a common framed ceiling opening to receive them. Coordinate with equipment.
5. Fixtures of the same type and in the same ceiling shall have lamps, socket assemblies and door hinges oriented in same direction.

K. Mounting:

1. For ceiling construction, refer to architectural drawings for finish schedules and refer to manufacturer's installation details and applicable codes for required fixture mounting accessories.
2. Verify all ceiling trims with Architectural Drawings.
3. For recessed mountings in plaster ceilings, provide plaster frames as follows:
  - a. For setting under General Construction Work.
  - b. With bottom of frames flush with finished ceiling.
4. Suspended Fixtures:
  - a. Individually pendant mounted units shall have canopies for pendants and junction box at the ceiling line for each fixture.
  - b. Continuously pendant mounted units shall have canopies for pendants and junction box for each continuous run except as noted.

L. Diffusers and Accessories:

1. Reflector cones, baffles, aperture plates, light controlling element for air handling fixtures and decorative elements shall be installed after completion of ceiling tiles, painting and general cleanup.

M. Cleaning:

1. Clean all fixture reflectors, lenses, louver, decorative accessories and lamps immediately prior to Owner's acceptance of building. Destaticize plastic lenses and diffusers after cleaning.

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- C. Unsatisfactory Fixtures:
  1. Replace blemished, damaged, or unsatisfactory fixtures as directed by the Lighting Designer.



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**END OF SECTION 26 51 13**



## **SECTION 27 00 00 - COMMUNICATIONS**

### **PART 1 - GENERAL**

#### **1.1 SCOPE**

- A. The objective of this and related specification documents is to define a universal and structured communications cable plant infrastructure for use on this project. The goal of such a cable plant is to accommodate all current and anticipated voice and data systems with little or no modification, thus reducing administration and maintenance demand for resources.
- B. The cable plant standards address a range of typical work areas found. The areas include fixed offices, open office furniture systems, raised floor areas, open ceiling areas, conference rooms and all support spaces. This document specifies the design and installation for the station outlet, station cabling, communication support rooms, equipment rooms, backbone cabling and the service provider company and access provider company entrance facilities.
- C. This document does not specify the communications equipment such as the network hubs, routers, telephone switch and servers. However, the interface between such equipment and the cable plant is defined herein.
- D. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and to all Division 27 Sections.
- E. This document details the minimum acceptable requirements for telecommunication solution to be installed for this project.

#### **1.2 DESCRIPTION OF SERVICES**

- A. General
  - 1. The contractor shall provide all personnel, equipment, tools, materials, vehicles, supervision, and other items and services necessary to perform all operation and technical oversight of construction for all components of the Communications Cabling Infrastructure System.
  - 2. The contractor will perform all work in accordance with all local, state and federal codes applicable, and / or noted on the construction documents.
  - 3. The contractor shall be fully responsible for compliance with all local, state, and Federal environmental/occupational safety laws, rules, and regulation.
  - 4. The contractor shall follow life and safety codes and take necessary actions to avoid conditions which may be hazardous to the health and safety of personnel.



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5. The contractor will coordinate, as necessary, with the designated site personnel, including the General Contractor, during the entire course of the project.
6. The contractor will be required to attend weekly construction meetings at the project site.
7. The contractor should be aware that this is a phased interior fit-out project with multiple trades working simultaneously. In addition, the areas outside of the current phase in construction are to be considered live production areas that cannot be disrupted. The contractor will be required to plan and phase its work according to the General Contractor's work schedule. The contractor should account for this in their bid.
8. The contractor shall coordinate with the GC and other trades on site to ensure pathways and other requirements are installed in a timely manner as to not affect the installation of cabling.

B. Telecommunications Structured Cabling Scope

1. Furnish, install, terminate, secure, label, and test a complete and operating system of Category 6 UTP cabling, outlets, faceplate, termination hardware, wire management and accessories as shown on the bid drawings.
2. Furnish, install, terminate, secure, label, and test a complete and operating system of Category 6A UTP cabling, outlets, faceplate, termination hardware, wire management and accessories as shown on the bid drawings for Wireless AP locations.
3. All cables shall be installed, routed, and supported in accordance with this document and bid drawings and communications specifications. All Horizontal cables shall be terminated according to the T568B wiring scheme.
4. Systems shall be tested in accordance with this document and the bid specifications.
5. All horizontal cables shall be continuous from the distribution rack mounted patch panels to the horizontal outlets without any field splices.
6. All horizontal cables shall follow prescribed routing utilizing cable tray, adjustable cable supports, j-hooks, and/or conduit stub-ups.
7. To feed the furniture system, furniture feeds will be provided via wall openings or utility poles, floor fed communication outlets routed to Cabling must be protected with split duct or similar once it leaves the wall and or utility pole until it enters the furniture system.
8. Horizontal cabling within the TR rooms shall be laid neatly on the ladder rack lined up along the length.
9. Fiber and copper cables shall be kept in separate bundles from each other and shall not run within the same conduit.
10. Furnish, label, and install cable tray in the ceiling of the office areas as shown. Cable tray shall be basket type and the contractor shall utilize factory bends, intersections, splices, etc. and shall only field modify the tray as allowed by the manufacturer so that structural integrity is maintained.
11. To support cables beyond the cable tray, provide J-hooks or similar approved product shall be used. At no point shall cabling be in contact with the concrete slab.



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12. Cables shall be routed in well-defined paths in bundles of 50 cables as much as possible. Cables shall not be run individually except where necessary. Cable pathways shall utilize the most efficient route, while also considering above ceiling and underfloor interferences by other trades. Cables shall be secured by means of velcro tie not plastic cable tie.
13. Furnish, label and install a minimum of a number 6-AWG stranded grounding conductor and 2-hole grounding lugs for each individual equipment rack/cabinet and cable tray to the telecommunications ground bus bar. Jumper each cable tray section to the next section.
14. Furnish, label and install computer generated labeling for the entire telecommunications system. Labeling must follow owner standards as specified.
15. Each cable shall be uniquely identified on the faceplate and patch panel label. All horizontal cables shall be labeled at both ends prior to termination. The labels shall be typed or produced with a label-making device and not hand-written.
16. Each outlet and corresponding patch panel shall be uniquely identified with an outlet id according to owner standards.
17. Every station cable pulled must be identified with a printed label at both ends containing the cable's Cable ID. The labels shall be placed on the cable 6 in. from the point of termination.
18. Every cabinet/rack must be identified with a printed label on top of both sides of the rack/cabinet according to the owner standards.
19. Every copper patch panel must have a printed label indicating cable/port ID.
20. Every fiber patch panel must have a printed label indicating source and destination as well as strand count.
21. Furnish and install replacement pull string for those used in cable installation in all stub-ups and conduits.
22. All conduits will be fitted with bushings, with conduits within a telecommunication space being fitted with a conduit waterfall.
23. Installation of Wireless access points is included within the scope of work, Access point and ceiling mounting hardware will be provided by the owner, information including MAC address, serial number and outlet ID will be documented on the As-Built set of drawings.
24. Each communications conduit whether utilized or not as part of this scope will be fire stopped.

### 1.3 BID PROPOSAL INSTRUCTIONS

A. Contractor shall provide the following as part of the bid submittal:

1. All requirements of the General Contractor
2. Complete Unit Price Form including quantities, part numbers and product descriptions for each manufacturer and corresponding distributor listed below.
3. Proof in writing from the manufacturer stating that the Communications Contractor is certified to install and extend the manufacturer's warranty for the proposed product solutions.
4. Resume for the Contractor's Project Manager, Foreman and the RCDD that will be assigned to the project.



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5. Corporate Resume to include recent like size jobs (size, scope, delivery time frame)
6. Corporate financial information and size of labor force.
7. Any exceptions, exclusions, or clarifications to the bid
8. Plan of action including but not limited to manpower, man-hours for total project, and typical working hours.

B. The Unit Price Form must be fully filled out and the following information included:

1. Labor Costs
2. Equipment and Materials
3. Tax(s)
4. Shipping & Delivery
5. Break-out of equipment rentals
6. OT or Shift Differential costs for acceleration
7. Miscellaneous items not included within the bid form should be added to the appropriate specification section.

C. Special instructions for bidding the Structured Cabling components

1. The unit price form has been constructed and labeled with all associated tabs and relevant part numbers
2. The Bidder must include pricing for the structured cabling (All Category) components listed.
3. The Bidder shall provide pricing for the preferred manufacturer structure cabling solutions
4. Failure to complete all requested pricing requirements may disqualify the Bidder from the project.
5. Manpower costs should be separated from material costs and included within the lower section of the Unit bid form
6. An explanation as to how tax has been applied to the project costs should also be included within the bid proposal response.
7. Costs for Patch cords shall be provided within the Unit price form on a unit price basis regardless of length supplied.

#### 1.4 WORK BY OTHERS

A. Owner

1. will provide:
  - a. Active electronics for interface with building voice and data cabling systems.
  - b. Wireless Access Points – Furnished by owner, installed by telecom contractor



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1.5 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including any included term and conditions, Refer to the following additional sections

1. Division 01 – General Requirements
2. Division 02 – Site work
3. Division 06 – Wood and Plastics
4. Divisions 11 – Equipment
5. Division 13 – Special Construction
6. Division 14 – Conveying Systems
7. Division 26 – Electrical

- B. Refer to the following specific division 27 sections

1. 27 05 10 - Communications Firestopping
2. 27 05 26 - Grounding and Bonding for Communications Systems
3. 27 05 28 - Pathways for Communications Systems
4. 27 05 29 – Hangers & Supports for Communications System
5. 27 05 43 – Underground Conduits and Duct Bank
6. 27 05 53 - Identification for Communication Systems
7. 27 11 16 – Communications Racks Cabinets & Enclosures
8. 27 11 19 - Communications Terminations Blocks and Patch Panels
9. 27 11 23 – Communications Cable Management & Ladder Rack
10. 27 11 26 – Rack mounted Power Protection & Power Strips
11. 27 13 23 – Communications Optical Fiber Backbone Cabling
12. 27 15 13 - Communications Copper Horizontal Cabling
13. 27 15 43 - Communications Faceplates and Connectors
14. 27 16 19 - Communications Patch cords and Station Cords

1.6 REFERENCES & STANDARDS

- A. This Infrastructure Standard is based on the TIA-568-D Series - Commercial Building Telecommunications Cabling Standards, and TIA-569-D Commercial Building Standard for Telecommunications Pathways and Spaces, along with others noted below. These documents are published by the Telecommunications Industry Association.

- B. The design, cable and component selection, and installation practices shall conform with the following codes:

1. Federal Communications Commission (FCC)
2. Americans with disabilities act (ADA)
3. National Electrical Code (NEC)
4. National Electrical Safety Code (NESC)
5. Occupational Safety and Health Association (OSHA)
6. Office of Statewide Health Planning and Development (OSHPD)
7. National Electrical Manufacturers Association (NEMA)
8. Applicable Underwriters Laboratories, Inc. (UL) Listings and Approvals



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9. National, state and local health, safety and building codes
- C. The design, cable and component selection, and installation practices shall conform with the following standards:
1. TIA/EIA-526-7A: Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
  2. TIA-526-14-C: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedure- Part 4-1: Installed cable plant- Multimode attenuation measurement
  3. ANSI/TIA-568.0-D, Generic Telecommunications Cabling For Customer Premises
  4. ANSI/TIA-568.1-D, Commercial Building Telecommunications Infrastructure Standard
  5. ANSI/TIA-568-D.2, Balanced Twisted-Pair Telecommunications Cabling and Components standard
  6. ANSI/TIA-568-3-D, Optical Fiber Cabling Components Standard
  7. ANSI/TIA-569-D, Telecommunications Pathways and Spaces
  8. ANSI/TIA-606-C, Administration Standard for Commercial Telecommunications Infrastructure
  9. ANSI/TIA-607-D Commercial Building Grounding and Bonding Requirements for Telecommunications
  10. ANSI/TIA/EIA-492AAAC-B, Detail Specification for 850nm Laser Optimized 50 Micron Core Diameter/125 Micron Cladding Diameter Class 1a Graded Index Multimode Optical Fibers
  11. ANSI/TIA/EIA 492AAAD Detail Specification for 850-NM Laser-Optimized, 50-um Core Diameter/125- um Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber
  12. TIA-758-B: Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
  13. TIA/EIA-862-B: Structured Cabling Infrastructure Standard for Intelligent Building Systems
  14. ANSI/TIA TSB-75: Additional Horizontal Cabling Practices for Open Offices
  15. ANSI/BICSI 002 – 2011: Data Center Design and Implementation Best Practices
  16. TIA-942: Telecommunications Infrastructure Standards for Data Centers
  17. TIA-1152: Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
  18. Federal Communications Commission Title 47 / FCC Part 15, FCC Part 68
  19. Institute of Electrical and Electronic Engineers (IEEE) 802.3, 802.5, 802.11
  20. National Electrical Code Article 770 “Optical Fiber Cables” and Article 800 “Communications Circuits”
  21. Local Electrical Code
  22. National Fire Protection Association (NFPA) 70 National Electrical Code
  23. NFPA 75 Protection of Electrical Computer/Data Processing Equipment
  24. OSHA 29 CFR 1926/1910 Safety and Health Standards
  25. UL 444 Communications Cables



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26. BICSI: Telecommunications Distribution Methods Manual (TDMM), 13th Edition Building Industry Consulting Services International (BICSI) or most current
27. BICSI Information transport systems installation Methods Manual (ITSIMM)

D. When a discrepancy arises between the above-mentioned codes, standards or guidelines and these documents this shall be brought to the attention of the GC and owner representative.

## 1.7 DEFINITIONS AND ABBREVIATIONS

A. The following definitions are specific to the communications environment and shall apply to this document and its companion sections for clarification and direction.

1. Advanced System Warranty: an extended warranty (20 or more years) held by the cabling manufacturer directly with the Owner that covers product guarantees and performance requirements for the entire cabling solution. Also see the associated Quality Assurance / Warranty section of this specification.
2. Backbone (Riser) Cabling: The portion of the communication link that connects each TR with the Data Center, Main Equipment Room or Entrance Facility. The Backbone cabling is typically run vertically in a star topology emanating from the Data Center, Main Equipment Room or Entrance Facility to all TRs. Backbone cabling consists of both copper and fiber cables.
3. Cable ID: A unique alpha-numeric identification used for tagging the station cables, the jacks within a communications outlet and the termination blocks.
4. Channel: Same as Permanent Link, but also includes patch cords at the Communications Outlet and in the Telecom Room.
5. Communications Cable Plant: All communications cabling, wiring, termination hardware, racks, cabinets, labeling and all other associated hardware.
6. Communications Outlet (Work area outlet): The device used to terminate station cables in couplers or connectors at user locations. It is the interface between the Station Cable and the end user's equipment.
7. Consolidation Point: In a Zone Cabling system, an intermediate connection point between the permanently installed cabling extending from the horizontal cross-connect or interconnect, and moveable horizontal cabling extending to the Telecommunications Outlet.
8. Contractor: The Communications Contractor or sub-contractors responsible for installation, termination, test and documentation of communications cabling, termination components, pathway hardware, telecommunications equipment room hardware and related components detailed in the technical sections of this Division of work.
9. Copper Backbone Field: RJ-45 style termination panel or 110-Block used to terminate backbone cabling in the Data Center, Main Equipment Room, Entrance Facility or TR.
10. CRAC: Computer Room Air Conditioner or any air conditioning (A/C) which is dedicated to cooling IT hardware rather than comfort cooling. These standalone units typically use chilled water, condenser water or refrigerant in association with remote heat rejection equipment to provide cooling via direct air supply (overhead or underfloor) or ducted distribution.



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11. Cross-Connect: Group of connection points, wall or rack mounted, used to mechanically terminate and administer building wiring.
12. Data Equipment Field: The area in a 19" rack that contains the active equipment that makes up the local area network. This equipment could be made up of hubs, switches or other active hardware.
13. Design Engineer: A member of the Syska Hennessy Group ICT team responsible for designing the project.
14. Electrical systems provide normal (utility) power, clean UPS power, back-up emergency power (EPS) to serve critical technology equipment and mechanical systems which support technology equipment and occupied spaces. Fire alarm systems fall under the electrical system category, typically, and consist of a system of devices intended to detect and alarm fire-related conditions to ensure the safety of occupants and to protect physical assets, from a building to technology equipment.
15. Entrance Facility (EF): The room where the Telephone Company or service provider point-of-demarcation (DEMARC) is installed or originates from their public facilities. This is the service hand-off point or the point of origin for extending the DEMARC to other rooms within the building.
16. EPS: An Emergency Power Supply (EPS) System which consists of generators, or another alternative source of power than the electric utility, along with electrical distribution equipment arranged in a manner which supports critical equipment in the event of a loss of normal input power. EPS systems require a small amount of time to start up, and as such are often utilized in conjunction with UPS systems to ensure continuous power. Automatic transfer switches (ATS's), in detecting a loss of normal power, send a signal to the EPS system to come on-line. When the EPS systems is at an acceptable operating level, usually in a 10 to 60 second time frame, the ATS units will transfer to the EPS system to provide a longer duration of back-up supply. In the case of a generator system EPS solution, the back-up supply of power can provide service as long as the fuel oil storage and re-supply is maintained. EPS systems, in addition to serving life safety equipment loads, serve critical environments by supplying UPS systems, technology room cooling systems, and lighting.
17. EPDU: Enclosure Power Distribution Unit (smaller multi-outlet assembly typically located in technology cabinets and racks).
18. Equipment Room (ER): Technology space in the building from which all building TR's are served. Within an element (building), this technology space is of the highest criticality. ER's may contain distribution layer LAN, localized voice system components, security, AV, various RF antenna systems, etc. There will be one ER per building.
19. Fiber Backbone Field: Fiber Optic Patch Panels used to terminate backbone cabling in the Data Center, Main Equipment Room, Entrance Facility or TR.
20. Horizontal (Station) Cabling: The portion of the communication link that connects the Communications Outlet to the TR. It is typically run horizontally on the same floor in a star topology emanating from the TR(s).
21. MEP: Mechanical, Electrical and Plumbing Systems. Mechanical systems (sometimes noted as HVAC) provide cooling, heating, ventilation and humidification through a system of fans, cooling towers, chillers, pumps, piping, ductwork, etc.



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22. "N" System: An "N" system is the minimum system configuration which will deliver the required system capacity without redundant components.
23. "N+1" Redundancy: "N+1" redundancy is the minimum system configuration which will deliver the required system capacity and includes one (1) spare power conversion device (i.e., pumps, fans, UPS modules, engine-generators). In an N+1 system, the energy delivery paths (i.e., pipes, ductwork, wire) can either be redundant or non-redundant.
24. Accordingly, the path of distribution may need to be designated as either single or dual (redundant).
25. Nationally Recognized Testing Laboratory (NRTL): Testing facility recognized by OSHA that provide product safety testing and certification services to manufacturers
26. Outlet ID: A unique alpha-numeric identification used for referencing a communications outlet. The Outlet ID is a subset of the Cable ID.
27. Outside Plant cabling (OSP): communications cabling and terminations primarily located outside of the building foot print including but not limited to copper and fiber optic cabling, splicing and terminations, lightening and electrical protection.
28. PDU: Power Distribution Unit. PDU's are typically combination transformer and panelboard units, rated between 50 and 300 kVA. These units are found serving and usually located within larger technology spaces.
29. Permanent (Cable) Link: Includes the Communications Outlet, station cable and termination at the Telecom Room.
30. Plenum: A compartment or chamber used as part of the air flow system within a user area. Assume all spaces above accessible ceilings are part of a plenum space.
31. Plenum Rated: listed by the Underwriters Laboratory as being acceptable for use within a plenum space. Cabling to installed or routed within a plenum space must be identified as Plenum rated or CMP
32. Plumbing systems provide hot and cold water sources for domestic use as well as water make-up for (HVAC) cooling equipment. Plumbing systems also provide waste removal and condensate removal. Fire protection systems, when not separately identified as "FP", typically are included in the plumbing discipline. Fire protection systems consist of sprinkler systems, pre-action systems, fire pumps, standpipe risers, gaseous suppression systems, etc., in order to provide a means of detecting and suppressing a fire, either automatically or manually.
33. Station Field: 8-position, 8-conductor Modular (8P8C; "RJ-45") termination panel used at the TR to distribute the station cables to the Station Outlets.
34. Substantial Completion: Stage in the schedule where the work or work of a designated area or space is sufficiently complete in order for the owner to utilize the space for commissioning or installation of owner provided equipment. In the case of a Telecommunications space this includes a dust free environment with a stable power supply and all support services fully functional.
35. Technology Equipment: Technology equipment encompasses servers, LAN switches, routers, SAN, NAS, MER cabling racks, carrier demarcation equipment, etc.
36. Telecommunication Room (TR): A room that serves as the distribution point of station cabling to the surrounding area referred to as the TR Zone, previously referred to as the Intermediate Distribution Frame (IDF) room. The TR also



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houses all the terminations of station and backbone cabling as well as network, voice, security and other active equipment. On a floor, one (1) or more TR's will be provided. TR's will converge IT, AV, Security, BMS, RF, Telemetry, Public Address, etc., into one room, with the majority of these systems migrating to Ethernet.

37. TR Zone: An area served by a Telecommunications Room. All Station Cabling from outlets in a TR Zone originate from that TR.
38. Uninterruptible Power Supply (UPS): A system which consists of conversion module(s), batteries and electrical distribution equipment arranged in a manner which supports critical equipment in the event of a loss of normal input power. UPS systems either filter and/or re-create the power sine wave, creating a clean, continuous supply of electrical energy during normal operation and when input power is lost. Besides providing clean, filtered power, UPS systems also act to bridge input power failures until a supply source such as the power utility can be re-established, or until a back-up emergency generator source, such as a generator, can be started. During a sustained loss of all input power sources, UPS systems can remain operational until their batteries systems are drained. UPS systems typically serve technology equipment, and are only used for cooling where high density computing pods cannot sustain the intense heat production of servers until restoration of a power source to the cooling system (such as when a generator starts) is complete.
39. Zone Cabling: A cabling plan, typically used in an open office area, which provides for a reconfigurable link between the horizontal cross-connect or interconnect (e.g. at the Telecom Room) and the work area / user. An intermediate connection point is positioned close to the workstations served.
40. 110-Block: References throughout this document to a 110-Block signify a 100-pair 110-block that is 4 rows high by 25-pair positions (i.e. 6 x 4-pair UTP cables) wide or a 300-pair 110-block that is 12 rows high by 25-pair positions (i.e. 6 x 4-pair UTP cables or 1 x 25-pair cable) wide regardless of manufacturer or mounting type, unless otherwise noted.
41. "2N" Redundancy: "2N" redundancy (system + system) is a system configured as two (2) "N" systems operating in parallel, each with the minimum number of power converters required to deliver the required system capacity. In a 2N system, the energy delivery systems (i.e., pipes, ductwork, wire) are also redundant with each system having the capacity to support the entire load. Each system must be adequately separated to ensure failures and required maintenance shutdowns of a single system do not result in the shutdown of the redundant system.
42. Furnish: to supply and deliver to the project site ready for instruction or installation.
43. Install: to place in position for service or use
44. Provide – to Furnish and install, complete and ready for the intended use.

## 1.8 ABBREVIATIONS AND ACRONYMS

- A. The following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction.



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1.	8P8C	Eight Position, Eight Conductor modular Jack. Often referred to as an "RJ-45".
2.	AFF	Above Finished Floor
3.	ANSI	American National Standard Institute
4.	ATM	Asynchronous Transfer Mode
5.	AWG	American Wire Gauge
6.	BAS	Building Automation System
7.	BDF	Building Distribution Frame
8.	cm	centimeters
9.	CM	Communications cable rated for general purpose use
10.	CMP	Communications cable rated for use in plenum areas
11.	CMR	Communications cable rated for use in risers and vertical runs
12.	CRAC	Computer Room Air Conditioner
13.	dB	Decibel
14.	DTMF	Dual Tone Multi Frequency
15.	EF	Entrance Facility
16.	ELFEXT	Equal-Level Far-End Cross Talk (pair-to-pair)
17.	EPDU	Enclosure Power Distribution Unit
18.	EPS	Emergency Power Supply
19.	FCC	Federal Communications Commission
20.	ft.	feet
21.	F/UTP	Foiled Unshielded Twisted Pair No shielding around individual pairs and an overall foil shield under the cable jacket
22.	HCP	Horizontal Connection Point
23.	IEEE	Institute of Electrical and Electronic Engineers
24.	in.	inch
25.	kg.	kilogram
26.	lbs.	Pounds
27.	LAN	Local Area Network
28.	m	meters
29.	mm	millimeters
30.	Mbps	Megabits per second
31.	MER	Main Equipment Room
32.	MHz	Mega Hertz (1E6 Hz)
33.	MEP	Mechanical, Electrical and Plumbing Systems
34.	μm	Micrometer or micron (10E-6 meter)
35.	N	Newton
36.	NEXT	Near End Cross Talk
37.	OFNP	Optical Fiber Nonconductive Plenum
38.	OFNR	Optical Fiber Nonconductive Riser
39.	OTDR	Optical Time Domain Reflectometer
40.	PBX	Private Branch Exchange (Telephone Switch)
41.	PDU	Power Distribution Unit
42.	pF	Pico Farad (10E-12 Farad)
43.	PSNEXT	Power Sum Near End Cross Talk
44.	PVC	Polyvinyl Chloride
45.	RU	Rack Unit (1.75 inches)



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46.	TER	Telecommunications Equipment Room
47.	TIA	Telecommunications Industry Association
48.	TR	Telecommunications Room
49.	UPS	Uninterruptible Power Supply
50.	USOC	Universal Service Order Code
51.	UTP	Unshielded Twisted Pair
52.	WAN	Wide Area Network

1.9 SUBMITTALS

- A. Submit documents for review and approval in accordance with the provisions of Section 01 33 00, Submittal Procedures
- B. Submit shop drawings for cabling and equipment provided under this Section:
  - 1. Note that for satisfying submittal requirements for Division 27, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 1. However, expression "Shop Drawings" is generally used throughout specification.
- C. Mark general catalog sheets and drawings to indicate specific items submitted.
- D. Include proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
- E. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Submittals shall be clearly marked and noted accordingly.
- F. When equipment and items specified include accessories, parts and additional items under one designation, submittals shall be complete and include required components.
- G. Submittals should be grouped to include complete documentation of related systems, products and accessories in a single submittal. Where applicable, dimensions shall be marked in units to match those specified.
- H. Submittals shall be in electronic form (Adobe Acrobat PDF) or paper.
  - 1. Paper documents shall be original catalog sheets or photocopies thereof.
  - 2. Facsimile (fax) sheets shall not be accepted.
- I. Where submittals cover products containing potentially hazardous non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.



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- J. Upon request by the owner or engineer, the contractor shall submit one 2-foot section of each cable type from cable reels sent to the site for Engineer's final approval. This two-foot section shall have manufacturer's cable markings visible.
- K. Submit floor plan outlet labeling drawings indicating the Communications Outlet ID for each communications outlet.
  - 1. Refer to Section 270553, Identification for Communications Systems, for description of Communications Outlet ID.
    - a. Floor plan outlet labeling drawings shall be provided, in AutoCAD.
  - 2. Drawings shall be submitted a minimum of twelve (12) weeks prior to substantial completion of the work associated with the corresponding outlets.

1.10 CHANGE ORDERS

- A. Promptly report requests for additional materials or work in writing and maintain written records of additions (change order request) separate from the original project.
- B. Changes to contractor's project scope, system routing, schedule or authorized budget must be approved in advance by the Owner. Contractor will not be paid for any work performed, or materials purchased without advance authorization and approval for the specific items of work or materials by the Owner.

1.11 QUALITY ASSURANCE

- A. Cable and component manufacturer(s) shall be a company specializing in communications cable, accessories and/or equipment with minimum of 5 years documented experience in producing cable, accessories and/or equipment similar to those specified herein.
- B. Telecommunications Subcontractor Qualifications
  - 1. Telecommunication Subcontractors (TCs) shall have total responsibility for the coordination and installation of the work detailed within the telecommunication drawing and specifications set.
  - 2. The Contractor shall have been in this business for minimum of 5 years and provide details of Five (5) reference projects equal in magnitude (in terms of number of drops and cost) to the project specified in the following sections.
  - 3. The Contractor shall have the necessary certifications to provide for the Warranty as specified herein.
    - a. The Contractor shall be an active participant in the Installers Program operated by the Manufacturer of the Cabling and/or Termination Components used. The Contractor shall be a participant in this program at the time of Bidding and remain so throughout the project.
    - b. Upon request, the Certified Installer(s) assigned to the Project shall be identified to the Engineer.



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4. The TC shall have a Registered Communications Distribution Designer (RCDD) on staff and provide a copy of the Current RCDD certificate for the person that will serve as the project RCDD.
5. The TC will provide certification proof that the company's intended lead Installer or foreman for the project is BICSI ITS Technician certified along with a resume detailing project experience and manufacturer certification training.
6. If the project requires outside plant work to be carried out, the contractor shall show proof of this type of project experience with five (5) project references dated no later than the last Five (5) years.
7. The TC shall comply with all manufacturers recommended installation instructions or procedures unless noted within the specification documents.
8. The TC shall inspect each item, material, product or piece of equipment, upon receipt, and again prior to installation and reject damaged or defective items.
9. The assigned Telecommunications Lead Installer or Foreman shall be on site at all times when division 27 work is being completed.
10. The assigned Telecommunications lead installer shall have an OSHA 30-hour construction card as evidence of completing an OSHA approved training program, a copy of this card shall be submitted along with the resume submission.
11. All installers on the project are required to have a minimum of BICSI ITS installer 1 training and have an OSHA 10-hour Construction Card. Certificates for installers certifications listed should be submitted within the bid submittal.

1.12 WARRANTY

- A. This Article is applicable to all Division 27 Sections.
- B. Refer to Division 1 General Provisions.
- C. Contractor shall warranty all parts and labor for a period of one year, commencing on the date of substantial completion of the work.
- D. Where indicated elsewhere in the Specification, Contractor will provide an additional extended warranty to the customer. The Contractor shall register the system and associated products with the manufacturer and ensure customer receives all warranty documents and instructions. Proof of the Contractor's ability to provide this warranty shall be provided as part of the bid process.
- E. Each warranty will provide remedy of any defects of workmanship and repair or replace any faulty components that fail during the warranty period, without additional cost to the owner.
- F. Provide (2) copies of a warranty binder containing:
  1. Warranty information for components and Contractor's labor.
  2. Signed and dated warranty documentation from the manufacturer for extended component warranties.



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3. Copies of a letter, on contractor firm's letterhead, signed and dated by a corporate officer or the regional manager, and additionally signed by the project manager. The letter shall state that the materials utilized are as specified in the contract, that installation complies with applicable manufacturers' specifications and telecommunications industry standards, and that the contractor performed required cable and link tests. Include statement that every cable and cable pair for copper and every strand for fiber has been tested.
- G. Provide a warranty on labor such that any installation or documentation found within one (1) year to be out of compliance with these specifications will be promptly repaired or replaced at no charge.
- H. Provide in warranty binder extended (15-30-year cabling and hardware manufacturer warranties) manufacturer warranties provided by this Project. Projects shall contain products eligible for extended manufacturer warranties.
- I. Warranty service shall be available 24 hours/day; 7 days/week. Emergency response shall be within two hours of notification. The classification of "emergency" shall be defined solely by the Owner. Longer response times are at the sole discretion of the Owner. If the contractor does not respond within two hours, or within the longer time prescribed by the Owner, the Owner may contract with others and the cable contractor shall reimburse the Owner its actual cost as a remedy.
- J. Scope of warranty includes equipment, devices, wiring, accessories, software, hardware, installation, programming, and configuration required to maintain a complete and operable system. Provide manufacturer's published recommended preventative maintenance procedures during warranty period. This shall apply to items except those specifically excluded, or items wherein a longer period of service and warranty is specified or indicated. Warranties shall be effective for one year, minimum, from date Certificate of Final Acceptance is issued. Use of systems provided under this section for temporary services and facilities shall not constitute final acceptance of work nor beneficial use by Owner and shall not institute warranty period. The warranty shall cover repair or replacement of defective materials, equipment, workmanship, and installation that may be incurred during this period. Warranty work is to be done promptly and to Owner's satisfaction. In addition, warranty shall cover correction of damage caused in making necessary repairs and replacements under warranty. Additional warranty responsibilities are:
  1. Obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in Owner's designated name.
  2. Replace material and equipment that require excessive service during guarantee period as determined by Owner.
  3. Provide 2-business day service beginning on date of Substantial Completion and lasting until termination of warranty period. Service shall be at no cost to Owner. Service can be provided by installing contractor or by a separate service organization. Choice of service organization shall be subject to Owner's approval. Submit name and a phone number that will be answered on a 24-hour basis each day of week, for duration of service.



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4. Submit copies of equipment and material warranties to Owner before final acceptance.
- K. At end of warranty period, transfer manufacturers' equipment and material warranties still in force to Owner.
1. If warranty work problems cannot be corrected immediately to Owner's satisfaction, advise Owner in writing, describing efforts to correct situation, and provide analysis of cause for problem. If necessary, to resolve problem, provide at no cost services of manufacturer's engineering and technical staff at site in a timely manner to analyze warranty issues, and develop recommendations for correction, for review and approval by Owner.
- L. Structured Cabling System (SCS) Manufacturers Extended Warranty:
1. SCS Systems will be covered by a two-part certification program provided by a single manufacturer and that manufacturer's certified vendor. Manufacturer shall administer a follow on program through the Vendor to provide support and service to the purchaser. The first part is an assurance program, which provides that the certified system will support the applications for which it is designed, during the 20-year warrantee of the certified system.
  2. The second portion of the certification is a 20-year warranty provided by the manufacturer and the vendor on products within the system (cords, telecommunications outlet/connectors, cables, cross-connects, patch panels, etc.).
  3. In the event that the certified system ceases to support the certified application(s), whether at the time of cutover, during normal use or when upgrading (e.g. ATM), the manufacturer and vendor shall commit to promptly implement corrective action.
  4. Documentation proving the cabling system's compliance to the End-to-End Link Performance recommendations, as listed in ANSI/TIA -568-D shall be provided by the Vendor prior to the structured cabling system being installed.
  5. The cabling system must conform to the current issue of industry standard ANSI/TIA/ -568. Performance requirements of this document must be followed. As well, workmanship and installation methods used shall be equal to or better than that found in the BICSI (Building Industry Consulting Service International) ITSI manual.
  6. Purchaser demands strict adherence to the performance specifications listed in ANSI/TIA-568 series standards.
  7. Manufacturer shall maintain ISO Quality Control registration for the facilities that manufacturer the product used in this cabling system.
- M. Owner's rights: This section shall not be interpreted to limit Owner's rights under applicable codes and under this Contract.
- N. Pathways Material and Installation Warranty: Provide services, materials and equipment necessary to warrant the installation and performance of pathway materials for a period of one year after beneficial use. Scope of warranty includes equipment, devices, installation and other work required to maintain a complete and operable system.



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Provide manufacturers published recommended preventative maintenance procedures during warranty period.

- O. Grounding and Bonding Material and Installation Warranty: Provide services, materials and equipment necessary for successful operation of GBS for a period of one year after beneficial use. Scope of warranty includes equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.
- P. Firestopping Material and Installation Warranty: Provide services, materials and equipment necessary to warrant the performance of Firestopping material for a period of one year after beneficial use, or longer if required by the local AHJ. Scope of warranty includes equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.

1.

1.13 SCHEDULING, EQUIPMENT AND STORAGE

- A. Schedule materials and equipment and other deliveries and make all arrangements as necessary to complete all work in accordance with the project construction schedules. Provide schedules of work to Owner's Representative as directed during construction.
- B. Schedule deliveries and unloading to prevent traffic congestion, blocking of access, and interference with work. Arrange deliveries to avoid larger accumulations that can be suitably stored at site. Provide all labor and equipment to rig, hoist, lower and move materials and equipment on and around site, within the building or on the roof.
- C. Contractor shall be present to accept all material deliveries related to this scope of work and shall sign for all deliveries. Produce and maintain a log of received materials in both hard and electronic format containing at a minimum:
  - 1. A description and quantity of received item(s);
  - 2. The date of receipt;
  - 3. The location the item was received;
  - 4. The location where the item is stored;
- D. Receive packaged materials at site in manufacturer's original, unopened, labeled containers. Do not open containers until approximate time for use.
- E. Provide lockable storage containers, or other Owner-approved secured storage methods, for all on-site secure storage of materials. Store materials at locations that will not interfere with progress of work. Arrange locations of storage areas and containers in approximate order of intended use.
- F. Store materials in a manner that will prevent damage to materials and structure. Store cementitious materials in dry, weather tight, ventilated spaces. Store ferrous materials



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to prevent contact with ground and to avoid rusting and damage from weather. Store electronic and performance-dependent items and materials according to manufacturer directions, and in environment no more extreme than the final permanent environment such equipment or materials will operate within.

- G. Provide documents to Owner's Representative for any claim of material or equipment deliveries not able to meet construction schedules.

1.14 SITE EXAMINATION

- A. Before submitting bid, Contractor shall visit the site and examine all work and operational areas, communication services, equipment and space conditions on which the work is in any way dependent so as to provide the best workmanship and operation according to the intent of the Specifications and Drawings. Report to the Owner's Representative any condition that might prevent the installation of the material and performance of work in the manner intended.

1.15 RECORD DOCUMENTS

- A. As-Built Drawings: Contractor shall maintain a set of Contract Plans at the project site on which current changes and the actual location of pathways, including underground and overhead conduits and cable trays, outlets, racks, connection hardware, outlets, etc. as installed, shall be marked in red pencil in a neat, legible manner. This set of plans shall show actual dimensions from construction lines so they may be readily found after covering. Plans shall include all rack, pathway, patch panel, wiring block, outlet and cable numbering/labeling and any other changes from the Contract Documents. Duct banks and vaults shall indicate exact GPS coordinates with duct banks identified at 50 foot minimums and at all turns.
- B. Within fifteen (15) days of completion of the project, Contractor shall transmit the As-Built information to the AE. The AE shall produce an electronic set of drawings reproduced from marked-up As-Built and deliver two (2) bound full-size hard copies, two (2) bound half-sized hard copies and (2) electronic copies in CD format to the Owner's Representative for approval.
- C. Record Documents: The following documents shall be presented to the Owner's Representative prior to final acceptance of the project. Bind three (3) complete sets of the following in a hard-backed three-ring binder:
  - 1. Signed letter from the Contractor stating their system portion of the project is complete and that all punch list items are completed;
  - 2. Signed letter from the Contractor stating that all materials used are as specified, that each component of the installation complies with all manufacturers' instructions and telecommunications industry standards, and that the contractor has performed all specified testing and/or commissioning;
  - 3. Inspection Certificate, where applicable;
  - 4. Copies of all permits, where applicable;



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5. Log of all Owner-requested changes;
6. Log of all RFIs (Requests for Information) and ASIs (Architectural Supplemental Instructions) with the actual RFI and ASI documents;
7. Copies of all communication change orders with a summary of changes;
8. Operating and Maintenance Manuals, operating instructions;
9. Additional copies of all Warranties and Guarantees.
10. Test Results: Transmit test results in accordance with the Specifications for each system

1.16 MAINTENANCE AND OPERATIONS MANUAL

- A. General: Provide one (1) preliminary bound set of Operations and Maintenance Manuals. Include parts list and all maintenance information furnished by the manufacture. Include supplementary or shop drawings where necessary to indicate points of service and maintenance. Include recommended periodic maintenance, operating instructions, and data and warranty forms from the manufacturer for each item of equipment installed. Provide address and 24-hour phone number of firm responsible under warranty. Items requiring service or correction during the warranty period shall be serviced within 24 hours of notification by Owner. Data in manuals shall be clean, neat copies and posted on typed, 8-1/2"x11" sheets. Drawings shall be accordion folded. An index shall be provided with contents listed in an orderly presentation according to Specification section.
- B. Number of Copies: The preliminary set of the O&M Manual shall be presented to the Owner's Representative for approval by the Designer. After approval of this set, indicated corrections shall be made and two (2) additional sets shall be prepared and the three (3) completed sets shall be transmitted to the Owner's Representative.
- C. Binding: Copies shall be bound in a hard-backed three-ring binder. A cover sheet will be affixed to the front and contain the name of the job, Owner, Architect, Designer, Contractor and the year of completion. The spine holder shall contain a binding label containing the name of the project, Owner and year of completion. Each copy shall have a typewritten index and tabbed dividers between equipment categories.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Contractor acknowledges with bid submission that products and distributor channels are prescriptive in Communication Division 27 specifications. The Owner encourages new and innovative approaches, and welcomes "the latest state-of-the art components or the Bidder's standard components" as indicated in sub-paragraph C above. However these are encouraged to be submitted as an alternate submission, as their rejection may result in disqualification of the entire proposal.



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- B. Notify Designer for an on-site visit to inspect material and equipment prior to installation.
- C. Materials and equipment shall be new, undamaged, and shall be UL listed for its use. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.
- D. Defects and damages of material shall be replaced. Furnish any new material as necessary and install the system at the Contractor's expense.
- E. Furnish equipment and material samples when requested by the Owner's Representative, within 21 days of request.
- F. Non-approved material and equipment must be removed from the jobsite.
- G. Items referred to in singular number in these Specifications and Drawings shall be provided in quantities necessary to complete work.
- H. Provide necessary tools and materials not specified in the parts list, (tie wraps, d-rings, screws, consumables (copper and fiber optic), hardware, etc.) and equipment, (ladders, hydraulic lifts, cable tuggers, storage containers, etc.) necessary to provide a complete and fully functional communications infrastructure system.
- I. Equipment and materials specified shall be of the quality and manufacturer indicated. The equipment specified is based upon the acceptable manufacturers listed.
- J. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to written approval by from Owner per the substitutions policy listed below.
- K. Materials and methods shall comply in every way with above cited Standards and Codes.
- L. All products and materials shall be selected to allow for future growth. Examples: Conduits and cable trays shall be sized for a minimum of 25% growth. Patch panels shall be sized for a minimum of 25% growth.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Refer to the individual technical specification sections for detailed Cable Routing and Installation, Testing and Documentation requirements. The following apply to all communications cabling and termination work.



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- B. Device or equipment mounting heights indicated in the Specifications, Drawings, and/or documents are intended to provide general guidelines and are provided according to general industry standards. Such guidelines may not be exact or accurate and may or may not conflict with other trades installation without verification. Field verify all dimensions and heights with other contractors, trades, or any shop drawings and ensure that such mounting heights are indeed practical and feasible as not to conflict with other installation and construction. If conflicts are discovered at any time during the construction, report to Designer or Owner's Representative immediately for resolution.
- C. If the contractor fails to provide such field verifications and failure results in erroneous installation, the contractor shall remedy such installation per Owner's Representative's direction at contractor cost.
- D. Maintain clearances around electrical and mechanical equipment to allow access for maintenance per NEC and local codes.
- E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom and access for service and maintenance as possible.
- F. Install all systems, materials, and equipment plumb and level, and parallel and perpendicular to building lines and other building systems and component. This condition applies to both exposed and concealed locations except where specifically indicated.
- G. All devices, outlets, sleeves and conduits can be field located by Owner's Representative within 15' of the designed locations prior to rough-in without extra compensation.
- H. Prior to start of work, racks and cabinets can be field located by Owner's Representative within 10' of the designed locations without extra compensation.
- I. Install cabling, wiring, and equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- J. Contractor shall protect all copper and optical fiber cabling from physical damage. Copper and fiber optic cables shall not be exposed to forces or handling factors that will degrade performance, such as crushing, pull stressing, twisting, or damaging sheath materials. Contractor shall secure any unattended copper and optical fiber cable whether on reels, in boxes or during placement where it may be on the ground or in some other manner exposed to damage.
- K. Contractor or manufacturer/assembler to install frames, patch panels and wiring blocks whether the components are fully populated with cables or not.
- L. Contractor shall install all work as indicated on the drawings and specifications unless otherwise indicated. Contractor shall notify Engineer and Owner in the event field



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conditions or discovery exposes an issue that would result in the installed system not meeting the design intent or expressed level of performance.

### 3.2 COORDINATION

- A. The drawings are diagrammatic and indicate generally the locations of material and equipment. These drawings shall be followed as closely as possible. Coordinate the work under this section with the architectural, structure, electrical, plumbing, heating and ventilation drawings, and drawings of other trades for exact dimensions, clearances and roughing-in locations. Cooperate with other trades in order to make minor field adjustments to accommodate the work of others.
- B. Coordinate work with other trades providing equipment intended for connection to the communication system. Where connections or outlets are indicated for connection to such equipment, coordinate final equipment location prior to proceeding with work.
- C. Coordinate work performed under this section with other trades performing work in the same area or where work under this section conflicts with work performed by other trades. Notify the General Contractor, AE and Owner where changes due to conflict are more than of a minor nature.
- D. Coordinate with Civil Contractor or Engineer for underground work associated with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service if indicated.
- E. Coordinate with Electrical Contractor for electrical work required to communication equipment. Provide power and connection requirements, including required voltage, phase and load information; wiring diagrams; outlet types and configurations; and exact outlet and equipment locations prior to start of work.
- F. Coordinate the work with the General Contractor and Ceiling Contractor so that above ceiling work is completed, inspected and accepted by the Owner prior to ceiling installation. Final adjustments can be made later.
- G. Coordinate all core drilling and penetrations of structural members, including structural walls, floor slabs, ceilings, beams and other members with the Architect or Structural Engineer prior to start of work.
- H. Coordinate installation of devices and sleeves required to be set in poured-in place concrete and other structural walls or components to be put in place as they are constructed.
- I. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of Work. Give particular attention to large equipment requiring positioning prior to closing in building.



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- J. If directed by the Owner's Representative, the Contractor shall, without extra charge, provide layouts of equipment and details of mounting methods for Designer's approval prior to installation to ensure proper execution of the work.

### 3.3 STRUCTURAL CONSIDERATION

- A. Install equipment and all telecommunication products, including but not limited to racks, hardware, pathways, supports and cabling so as to properly distribute those weight loads on supporting building structural members provided under other Sections. Roof-mounted equipment shall be installed and supported on structural steel or roof curbs as appropriate.
- B. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall and ceiling mounting of equipment as required.
- C. Provide steel supports and hardware for proper installation of hangers, anchors, guides, and other support hardware.
- D. Structural steel and hardware shall conform to ASTM standard specifications. Use of steel and hardware shall conform to requirements of AISC Code of Practice: Section Five.

### 3.4 CABLE ROUTING– GENERAL

- A. Backbone cables should be routed separately from other building services so as to protect the cabling from unnecessary abuse. Separate conduit or a telecommunications riser shaft is recommended when it is deemed feasible.
- B. When redundant riser paths are available, the backbone cables should be run in the two different paths to provide backup in the case of damage to one of the cables. The size of each redundant cable should be half of the typical single backbone run, so that the total strand/pair count of the two cables is equal to the total strands/pairs required for the TR.

### 3.5 CABLE INSTALLATION – GENERAL

- A. The contractor shall furnish all required installation tools to facilitate cable pulling without damage to cable jacket.
- B. All routing shall be kept clear of other trades work and supported using the method(s) detailed in the pertinent technical section(s).
- C. During pulling operation an adequate number of workers shall be present to allow cable observation at all points of raceway entry and exit, as well as to feed cable and operate pulling machinery.



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- D. Pull cables in accordance with cable manufacturer's recommendations.
- E. Pull all cable by hand unless installation conditions require mechanical assistance.
  - 1. Where mechanical assistance is used, ensure that maximum tensile load for cable is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of "break-away" or other approved method.
- F. All cables shall be installed splice-free unless otherwise specified.
- G. Avoid abrasion and other damage to cables during installation.
- H. Cable manufacturers recommended pulling tensions shall not be exceeded.
- I. Pulling lubricant may be used and shall:
  - 1. Be non-injurious to cable jacket and other materials used.
  - 2. Not harden or become adhesive with age.
- J. Minimum bend radii, as specified by the manufacturer, must be adhered to for cable pulling and final installation.
  - 1. Any cables bent or kinked to radius less than recommended dimension are not allowed and shall be replaced at no expense to Owner.
- K. Repair damage to interior spaces caused by installation of cable, raceway or other hardware. Repairs must match preexisting color and finish of walls, floors and ceilings.
- L. Replace contractor-damaged ceiling tiles to match color, size, style and texture.
- M. Pull cord (200 lb. minimum) shall be installed with cable installed in conduit or inner duct.
- N. Cabling shall be neatly laced, dressed and supported.
- O. In a high-rise environment, provisions must be made to support the backbone cable passing vertically through the building. The cables should be supported on each floor using an industry approved support method.

### 3.6 TESTING

- A. Tests shall be conducted by the contractor during the course of construction when identifiable portion(s) of installation is complete. Alternatively, testing can be conducted after entire installation is complete if this does not delay the project schedule.
- B. Prior to testing, the contractor shall submit a written description of the intended test procedures and submit sample test forms to the Engineer.



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1. The submitted information shall include the proposed file naming format to be used in identifying the balanced twisted-pair cable (by 4-pair unit or pair), or optical fiber (by pair or strand) which is the subject of the test record.
  2. Failure to provide the above information shall be grounds for the Engineer or the Owner to reject any and all Documentation of Results on related testing and to require a repeat of the affected test.
- C. Prior to testing, the contractor shall submit to the owner (or owners representative) and the Engineer, a proposed schedule for acceptance testing. This notification shall be a minimum of five (5) working days in advance to allow for witnessing of the tests by a duly authorized representative.
- D. The Contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests.
- E. Testing shall be completed and accepted by Owner and Engineer before Owner furnished equipment and cross connects are installed.
- F. The Cabling Contractor shall be responsible for recording all test data and per the specifications. All cables shall be tested. All tests shall be documented.
- G. Test results shall be submitted in the native software of the Level IV field test measurement device, within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.) or no later than three (3) weeks prior to the scheduled occupancy of the subject area, whichever is earlier.
1. Interim documentation of Test Results in the native software of the field test measurement device shall be submitted in electronic form on CD-ROM for review and distribution.
- H. Test results in the native software of the Level IV field test measurement device shall also be part of the Final Documentation package submitted by the Contractor on the project.

### 3.7 DOCUMENTATION

- A. Upon completion of the installation, the Contractor shall provide System Documentation to the Engineer for approval. Documentation shall include:
1. Test Results
  2. Record Drawings
  3. Copies of all approved submittals indicating products used in the installation.
  4. Phone numbers, physical addresses and Internet/webpage (URL) of local parts suppliers and service companies covering the products installed.
- B. Submit four (4) copies of all required documentation.



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- C. Documentation of Test Results shall be submitted in electronic form on CD-ROM for review and distribution.
  - 1. Test results shall be submitted in the format(s) native to the test instrument(s) used in performing the testing.
  - 2. Where unique software (other than MS-Word™ compatible Word Processor or MS-Excel™ spreadsheet) is required for viewing of the test results, the Contractor shall provide along with the above documentation, three (3) licensed copies of such software. The software shall run on a Microsoft Windows-based personal computer supplied by the Owner.
- D. Final Documentation shall be submitted no later than three (3) weeks prior to the scheduled occupancy of the subject area. This is inclusive of all Test Results and draft Record Drawings.
  - 1. Draft drawings may include mark-ups done by hand.
  - 2. Machine generated (final) copies of all drawings shall be submitted within thirty (30) working days of the completion of each testing phase.
- E. The Engineer or Owner may request that a 10% random field re-test be conducted on the cable system - at no additional cost - to verify documented findings. Tests shall be a repeat of those defined above and in the technical sections. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Engineer or Owner, including a 100% re-test. This re-test shall be at no additional cost to the Owner.
- F. All documentation - including hard copy and electronic forms of all Test Data and Record Drawings- shall become the property of the Owner.

### 3.8 FIRE STOPS AND ENCLOSURES

- A. Maintain fire-resistance rating of walls, partitions, floors, ceilings or other fire separation barriers whenever work requires penetrations or openings for equipment. Provide and use approved methods and fire seal material and fittings to maintain the fire-resistance rating. Provide approved fire rated enclosures consisting of multiple layers of gypsum wall board or other approved materials to maintain the correct wall fire resistance rating for any communication panels or enclosures installed in fire rated walls.
- B. Locate devices horizontally a minimum of 24" apart on opposing sides of a fire separation wall to maintain the fire rating of the wall.
- C. Provide fire-stopping materials and methods in accordance with the project Specifications.
- D. For projects where sprayed fireproofing is specified:
- E. Install clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed prior to start of spray fire proofing work.



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1. Products such as conduit, cable tray, and other items that would interfere with proper application of fireproofing shall be installed after completion of spray fire proofing work.
2. Any work or repairs necessary due to Contractor's damage or disturbance of fireproofing shall be performed by the fireproofing contractor. All costs for this work and repair shall be paid by the Contractor responsible for the damage or disturbance.

3.9 ACCESS AND ACCESS PANELS

- A. All materials and equipment that require inspection, replacement, repair or service shall remain readily accessible.
- B. Provide access panels and/or doors as required to allow service of equipment components. Provide access panels where installed products require access and are concealed in floor, wall, furred space or above ceiling.
- C. Access panels shall not be less than 12" x 12" in size.
- D. Ceilings consisting of lay-in or removable splined tiles do not require access panels.
- E. Locations of equipment requiring access shall be noted on record drawings.
- F. Access panels shall have same fire rating classification as surface penetrated.
- G. Where access panels, doors or other items are installed to provide ready access to telecom systems, provide a detailed schedule prepared in Microsoft Excel noting location, size and function of the covered system. This schedule shall be included in the Operations and Maintenance Manual.
- H. Contractor is responsible for cleanup of debris on a daily basis. Cost of cleanup is the responsibility of the Contractor.
- I. Provide for the removal from the site of spoils, debris, boxes, packaging, crates, and trash generated from the work.
- J. During progress of work, remove equipment and unused material. Put building and premises in neat and clean condition. Perform cleaning and washing required to provide acceptable appearance and operation of equipment to satisfaction of Owner's Representative.
- K. Upon completion, cable contractor to vacuum utilizing a commercial HEPA filtration vacuum cleaner and clean floors, racks and equipment where work has been performed. This condition is intended but not limited to CNR, MDF, IDF rooms and rows and other cable room or rack areas and within cable trays in all areas.



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- L. After completion of Project, clean exterior surface of all equipment, Remove all concrete residue, dirt, and paint residue. This work shall be performed before final acceptance and punch walk by Owner.

3.10 INSTRUCTION PERIODS FOR OWNER'S PERSONNEL

- A. Scope: Following installation of work, have representatives of installation tradesmen conduct demonstrations and instruction periods to demonstrate the proper operation of equipment or system; and to point out locations of servicing points and required points of maintenance to Owner's Representative.
- B. General Description of Instruction Periods: Each period shall include preliminary discussion, and presentation of information from maintenance manuals with appropriate reference to Drawings; followed by tours of building areas explaining operational methods, maintenance requirements, access methods, servicing and maintenance procedures and any available adjustments.
- C. Scheduling of Instruction Periods: Notice of Contractor's readiness to conduct such instruction and demonstration shall be given Owner's Representative at least two (2) weeks prior to the instruction periods, and agreement reached as to the date at which the instruction periods are to be performed. Receive approvals of proposed date prior to making final arrangements.

3.11 STARTUP AND OPERATIONAL TESTING

- A. Owner maintains right to have access to entire project site to prepare facility for occupancy and operation.
- B. Completion of start-up and field testing shall be accomplished as a prerequisite for substantial completion. Operate and maintain systems and equipment until final acceptance by Owner.
- C. Guarantees and warranties shall not begin until Owner's final acceptance of systems and equipment. Such acceptance requires complete systems startup and testing at minimum.

**END OF SECTION 27 00 00**



## **SECTION 27 05 10 - FIRESTOPPING FOR COMMUNICATIONS SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Firestopping for Communications Systems.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

#### **1.2 SUBMITTALS**

- A. Provide product data from manufacturer's specifications.

#### **1.3 WORK INCLUDED**

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.
- B. The work shall include, but not be limited to the following:
  - 1. Furnish and install all firestopping materials.

### **PART 2 - PRODUCTS**

#### **2.1 APPROVED PRODUCTS**

- A. Approved Firestopping Manufacturer(s)
  - 1. Flamestopper Thru-Wall Fitting - Wiremold Company (Firestop Devices)
  - 2. Unique Firestop Products (Firestop Devices)
  - 3. STI Firestop Products (Firestop Devices, Putties, Caulks, Sealants, etc.)
  - 4. Hilti (Putties, Caulks, Sealants, etc.)



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## 2.2 TYPES OF PRODUCTS

### A. Sealants

1. Intumescent Firestop Sealants and Caulks
2. Latex Firestop Sealant
3. Acrylic Water-Based Sealant
4. Silicone Firestop Sealants and Caulks
5. Firestop Putty
6. Firestop Collars
7. Wrap Strips
8. 2-Part Silicone Firestop Foam
9. Firestop Mortar
10. Firestop Pillows
11. Elastomeric Spray
12. Accessories:
13. Forming/Damming Materials: Mineral fiberboard or other type as per manufacturer recommendation

### B. Firestop Devices

1. Thru-Wall Fitting (Flamestopper by Wiremold)
  - a. The firestop device box shall be constructed of 16 gage G90 steel.
  - b. The firestop device intumescent block shall be constructed of a graphite base material with expansion starting at 375°F and an unrestrained expansion between 6 to 12 times. The intumescent block shall be held securely by the box in order to prevent tampering and damage during installation.
  - c. The firestop device shall have doors which can be adjusted to prevent materials from penetrating the device if the device is empty or completely full. The doors shall be constructed of 16 gage G90 steel with No. 10-32 screws use to adjust opening size.
  - d. The firestop device shall be available for 2" and 4" trade size EMT conduit.
  - e. The firestop device shall be available in safety yellow powder coat, custom colors and an unpainted galvanized finish.
2. Threaded Firestop Device (Unique Firestop Products)
  - a. Threaded steel sleeve device incorporating flat washers secured by threaded device shall be installed around cables. The device shall be available in 1, 2 and 4-inch sizes. Maximum diameter of the wall penetration for 1, 2 and 4-inch sizes shall be 1-1/4, 2-7/16 and 4-1/2 inches respectively.
3. Smooth Firestop Device (Unique Firestop Products)
  - a. Smooth steel sleeve device incorporating flat washers secured by sliding compression couplers. The device shall be available in 1, 2 and 4-inch sizes. Maximum diameter of the wall penetration for 1, 2 and 4-inch sizes shall be 1-1/4, 2-7/16 and 4-1/2 inches respectively.
4. Split-Sleeve Firestop Device (Unique Firestop Products)



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- a. Threaded steel sleeve halves incorporating split couplings and slotted washers to fit the specific diameter of the opening. The device shall be available in 1, 2 and 4-inch sizes. Maximum diameter of the wall penetration for 1, 2 and 4-inch sizes shall be 1-1/4, 2-7/16 and 4-1/2 inches respectively.
- 5. Fire Rated Cable Pathway (STI EZ-PATH)
  - a. Fire rated cable pathway device modules shall be comprised of steel raceway with intumescent foam pads allowing 0-100 percent cable fill.

## 2.3 UL CLASSIFICATION

- A. Thru-Wall Fitting - The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL1479 (ASTM E 814) and bear the U.S. and Canadian UL Classification Mark.
- B. Threaded, Smooth and Split-Sleeve Firestop Devices - Firestopping sealants and devices shall be used together as a firestop system. All firestop systems shall bear a UL Classification system number. UL Classification system numbers are as follows:
  - 1. Threaded Firestop System
    - a. Block Wall - W-J-3049
    - b. Dry Wall - W-L-3138
  - 2. Threaded Firestop System (Vertical)
    - a. Slab - F-A-3010
  - 3. Smooth Firestop System
    - a. Block Wall - W-J-3048
    - b. Dry Wall - W-L-3137
  - 4. Split-Sleeve Firestop System
    - a. Block Wall - W-J-3047
    - b. Dry Wall - W-L-3136

## 2.4 FIRESTOPPING SYSTEMS

- A. Thru-Wall Fitting Firestop System:
  - 1. The device shall be classified for use in one-, two-, three, and four-hour rated gypsum, concrete and block walls and provide a maximum L rating of six cfm. The devices shall also been tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces.
- B. Threaded, Smooth and Split-Sleeve Firestop Systems:



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1. Shall conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire tests in a configuration that is representative of field conditions.
  2. The F rating must be a minimum of one (1) hour but not less than the fire resistance rating of the assembly being penetrated. T rating when required by code authority shall be based on measurement of the temperature rise on penetrating item(s). The fire test shall be conducted with a minimum positive pressure differential of 0.01 inches of water column.
  3. For joints, must be tested to UL 2079 with movement capabilities equal to those of the anticipated conditions.
- C. Firestopping materials and systems must be capable of closing or filling through-openings created by 1) the burning or melting of combustible pipes, cable jacketing, or pipe insulation materials, or 2) deflection of sheet metal due to thermal expansion (electrical & mechanical duct work).
- D. Firestopping material shall be asbestos and lead free and shall not incorporate nor require the use of hazardous solvents.
- E. Firestopping sealants must be flexible, allowing for normal pipe movement.
- F. Firestopping materials shall not shrink upon drying as evidenced by cracking or pulling back from contact surfaces.
- G. Firestopping materials shall be moisture resistant, and may not dissolve in water after curing.

### PART 3 - EXECUTION

#### 3.1 CONDITIONS REQUIRING FIRESTOPPING

- A. General
1. Provide firestopping for conditions specified whether or not firestopping is indicated, and if indicated, whether such material is designed as insulation, safing, or otherwise.
- B. Through-Penetrations
1. Firestopping shall be installed in all open penetrations and in the annular space in all penetrations in any bearing or non-bearing fire-rated barrier.
- C. Membrane-Penetrations



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1. Where required by code, all membrane-penetrations in rated walls shall be protected with firestopping products that meet the requirements of third party time/temperature testing.

D. Construction Joints/Gaps

1. Firestopping shall be provided between the edges of floor slabs and exterior walls, between the tops of walls and the underside of floors, in the control joint in masonry walls and floors and in expansion joints.

E. Smoke-Stopping

1. As required by the other sections, smoke-stops shall be provided for through-penetrations, membrane-penetrations, and construction gaps with a material approved and tested for such application.

3.2 EXAMINATION

- A. Examine the areas and conditions where firestops are to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Verify that environmental conditions are safe and suitable for installation of firestop products.
- C. Verify that all pipes, conduit, cable, and other items that penetrate fire-rated construction have been permanently installed prior to installation of firestops.

3.3 INSTALLATION

A. General

1. Installation of firestops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
2. Apply firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, and manufacturer's recommendations.
3. Unless specified and approved, all insulation used in conjunction with through-penetrants shall remain intact and undamaged and may not be removed.
4. Seal holes and penetrations to ensure an effective smoke seal.
5. In areas of high traffic, protect firestopping materials from damage. If the opening is large, install firestopping materials capable of supporting the weight of a human.
6. Insulation types specified in other sections shall not be installed in lieu of firestopping material specified herein.



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7. All combustible penetrants (e.g. non-metallic pipes or insulated metallic pipes) shall be firestopped using products and systems tested in a configuration representative of the field condition.

B. Dam Construction

1. When required to properly contain firestopping materials within openings, damming or packing materials may be utilized. Combustible damming material must be removed after appropriate curing. Noncombustible damming materials may be left as a permanent component of the firestop system.

3.4 FIELD QUALITY CONTROL

- A. Prepare and install firestopping systems in accordance with manufacturer's printed instructions and recommendations.
- B. Follow safety procedures recommended in the Material Safety Data Sheets.
- C. Finish surfaces of firestopping that are to remain exposed in the completed work to a uniform and level condition.
- D. All areas of work must be accessible until inspection by the applicable Code Authorities.
- E. Correct unacceptable firestops and provide additional inspection to verify compliance with this Specification.

3.5 CLEANING

- A. Remove spilled and excess materials adjacent to firestopping without damaging adjacent surfaces.
- B. Leave finished work in a neat and clean condition with no evidence of spill-overs or damage to adjacent surfaces.

3.6 IDENTIFICATION

- A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

**END OF SECTION 27 05 10**



## **SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 GENERAL**

- A. The contractor is responsible for proper installation of a grounding (earthing) backbone that has been designed and installed in accordance with TIA-607-D or equivalent regional Standard. If such grounding (earthing) backbone does not appear to be in place, Contractor shall inform GC, who will take action as appropriate.
- B. All bonding and Grounding (earthing) shall track methods and procedures described in TIA-607-D or equivalent regional standard.

#### **1.2 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 27 00 00 "Communications" including all referenced codes, guidelines and standards.

#### **1.3 RELATED WORK**

- A. Refer to Section 27 00 00 "Communications" which identifies related specification sections in this and other Divisions (if applicable).
- B. Related sections in other Divisions of Work:
  - 1. Section 26 05 26 "Grounding and Bonding for Electrical Systems".

#### **1.4 SUMMARY**

- A. Section Includes:
  - 1. Grounding conductors.
  - 2. Grounding connectors.
  - 3. Grounding busbars.
  - 4. Grounding labeling.
- B. Grounding and bonding systems are an integral part of the telecommunications cabling system. In addition to helping protect personnel and equipment from hazardous



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voltages, a proper grounding and bonding system will improve the electromagnetic performance of the cabling system. Improper grounding and bonding can allow induced voltages and conducted noise, which can disrupt signal transmission. The telecommunications grounding and bonding system shall conform to local codes and TIA-607-C.

1.5 DESCRIPTION OF WORK:

- A. Furnish and install a complete and fully functioning grounding and bonding system. All cables, terminations, support hardware, labeled and documented by the Telecommunications Contractor (TC).
- B. Coordinate with electrical contractor including pathways, termination points, busbar locations and connections to the main electrical service ground and electrical distribution panels.
- C. Provide all labor, materials, tools, equipment, and services required to provide and place into satisfactory and successful operation a complete, fully functional and permanent grounding and bonding system for communications circuits, raceways, and cable trays as herein specified and/or shown on the Contract Documents.
- D. Where indicated, provide coordinate with the Telecommunication Designer and Electrical Contractor for locations where the Telecommunication Grounding system interfaces or uses common elements of or with the Electrical Grounding system.
- E. Electrical Contractor shall provide backbone bonding system and provide grounding busbars in telecommunication spaces and rooms. Telecommunication contractor shall provide grounding systems as described herein and on plans from equipment specified in Division 27 to the grounding busbars.
- F. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA and ISO/IEC compliant Grounding and Bonding system
- G. Conduits, conductors, electrodes, busbars, fittings and other materials and appurtenances shall be UL listed, approved and suitable for the use and environment where installed.
- H. Notify the Owner's Representative at least two (2) full working days prior to covering of concealed communications work.

1.6 SYSTEM DESCRIPTION

- A. Bond the following items to the building telecommunication bonding system.
  - 1. Communications system active equipment.
  - 2. PDU and surge protection equipment.



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3. Raised floor systems.
4. Underfloor grounding grids for computer or telecommunications rooms.
5. Metallic raceway systems, including metallic cable trays.
6. Communications equipment enclosures (cabinets), racks or cross connect frames.
7. Broadband passive devices.
8. Metallic splice cases.
9. Metallic cable screens, armor or shields.
10. Metal cable conduit.
11. Grounding Electrode System.
12. Electrical service panels in entrance facilities, telecommunications and equipment rooms.
13. Busbars.
14. Exposed building steel that is within 6 feet of equipment racking systems.
15. Building steel extending to earth in outside-plant.
16. Related bonding accessories.

## 1.7 DEFINITIONS

- A. Refer to Section 27 00 00 "Communications" which identifies pertinent DEFINITIONS AND ABBREVIATIONS
- B. Additional definitions (per referenced standards):
  1. Bonding Conductor for Telecommunications (BCT): conductor that interconnects telecommunications bonding infrastructure to building's service equipment (power) ground.
  2. Bonding: The permanent joining of metallic parts to form a electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.
  3. EMT: Electrical metal tubing
  4. Exothermic Weld: method of permanently bonding two metals together by controlled heat reaction resulting in molecular bond.
  5. Grounding Equalizer (GE): conductor that interconnects elements of telecommunications grounding infrastructure. For example, a bonding conductor that interconnects TGBs on the same floor.
  6. Ground: A conducting connection whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth
  7. Irreversible Compression: permanent mechanical bond between conductors or conductor and connector using mechanical or hydraulic tool.
  8. Rack Bonding Conductor (RGC): a bonding conductor used to connect an equipment rack directly to the TMGB or TGB.
  9. Rack Bonding Busbar: A busbar that is vertically mounted on an equipment rack.
  10. Telecommunications Main Grounding Busbar (TMGB): busbar placed in convenient and accessible location and bonded by means of bonding conductor for telecommunications to building service equipment (power) ground.



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11. Telecommunications Grounding Busbar (TGB): interface to building telecommunications grounding system generally located in telecommunications room. Common point of connection for telecommunications system and equipment bonding to ground, and located in telecommunications room or equipment room.
12. Telecommunications Bonding Backbone (TBB): conductor that interconnects tele-communications main grounding busbar (TMGB) to telecommunications grounding busbar (TGB).

1.8 SUBMITTALS

- A. Refer to Section 27 00 00 "Communications" which provides general guidelines for product or installation information to be submitted by Contractor.
- B. Product Data: For each type of product.
- C. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.
- D. Manufacturer's Catalog Data shall be submitted for the following items at minimum:
  1. Cable hooks and hangars.
  2. Metallic and nonmetallic conduit, fittings and hangars.
  3. Outlet, pull and junction boxes.
  4. Cable tray and related hardware.
  5. Innerduct.
  6. Fire-rated sleeve assemblies.
  7. Support materials and hardware for products specified in this Section.
- E. Data shall include a complete list of parts, special tools, and supplies with source of supply.
- F. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
  1. Ground rods.
  2. Ground and roof rings.
  3. BCT, TMGB, TGBs, and routing of their bonding conductors.
- G. Qualification Data: For installation supervisor, and field inspector.
- H. Qualification Data: For testing agency and testing agency's field supervisor.
- I. Field quality-control reports.



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1.9 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
    - a. Result of the ground-resistance test, measured at the point of BCT connection.
    - b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.10 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  - 1. Refer to Section 27 00 00 "Communications" which identifies general quality assurance requirements for the Project.
  - 2. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
  - 3. Field Inspector: Currently registered by BICSI as a registered communications distribution designer to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All bonding conductors and connectors shall be listed for the purpose intended and approved by a Nationally Recognized Testing Laboratory (NRTL).

2.2 MATERIALS

- A. Materials shall be listed or shall be equivalent products of other manufacturers meeting the intent and quality level of this specification. Materials must be compatible with the end to end solution being proposed. Proposals for equivalent products must be presented for approval via the GC within RFI, submittal or shop drawing format. Written approval from the Client or their representative is required before any substitutions are made.

2.3 SYSTEM COMPONENTS

- A. Comply with TIA Standard TIA-607-C.



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2.4 CONDUCTORS

- A. Conductors shall be copper. Bare and insulated conductors are permitted. The NEC specifies criteria for mechanical protection.
- B. Conductors shall comply with UL 486A-486B.
- C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
- D. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
  - a. Chatsworth Part number: 40159-001
- E. Cable Tray Equipment Grounding Wire: No. 6 AWG
- F. Cable Tray Grounding Jumper:
  - 1. Not smaller than No. 10 AWG and not longer than 12 inches (300 mm). If jumper is a wire, it shall have a crimped grounding lug with one hole and standard barrel for one crimp. If jumper is a flexible braid, it shall have a one- or two-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.
    - a. Chatsworth Part number: 40164-0XX
- G. Bare Copper Conductors:
- H. Solid Conductors: ASTM B 3.
- I. Stranded Conductors: ASTM B 8.
- J. Tinned Conductors: ASTM B 33.
- K. Bonding Cable: 28 kmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
- L. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor
- M. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  - a. Chatsworth Part number: 40132-953
- N. Comply with UL 486A-486B.
- O. Rack grounding Jumper Kit
  - 1. Chatsworth Part number: 40159-008
  - 2. Chatsworth Part number: 40159-010



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2.5 CONNECTORS

- A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Chatsworth Part number: 08009-0XX
- D. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
  - 1. Electroplated tinned copper, C and H shaped.
    - a. Chatsworth Part number: 40163-0XX
- E. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.
  - a. Chatsworth Part number: 34828-01
- F. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.
  - a. Chatsworth Part number: 40162-953

2.6 COMPRESSION LUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following or an approved equal:
  - 1. Harger Lightning and Grounding
  - 2. Hubbell
- B. Meets TIA-607-C requirements for network systems grounding applications.
  - 1. Tested by Telcordia – meets NEBS Level 3 with AWG conductor.
- C. UL Listed and CSA Certified with AWG conductor for use up to 35 KV and temperature rated 90°C when crimped with Panduit and specified manufacturers' crimping tools and dies.
- D. Have an "inspection window" over tongue to visually assure full conductor insertion.
- E. Tin-plated to inhibit corrosion.



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- F. Available with NEMA and BICSI hole sizes and spacing.
- G. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- H. Compression Type
- I. Two holes lugs
- J. Long barrel that will allow a minimum of two crimps with standard industry colors.
- K. Crimped according to manufacturer's recommendation.
- L. Size:
  - 1. #2/0 AWG
  - 2. #6 AWG
  - 3. Material: copper or alloy copper.
  - 4. Approved Manufacturer: Gedney, Ilco, Eritech or approved equal
  - 5. LCC Series,
    - a. Panduit two-hole compressing lugs for code conductors in BICSI hole spacing

2.7 TAPS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following or an approved equal:
  - 1. Harger Lightning and Grounding
  - 2. Hubbell
- B. Connections to the conductor shall be made with irreversible compression connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- C. Shall be able to accept 6 AWG to 3/0.
- D. Shall require a minimum of two (2) crimps for C Tap and H Tap, one (1) crimp for I-Beam and busbar Tap.
- E. Crimp according to manufacturer's recommendation.
- F. Code Conductor, Thin Wall, Tin-plated C-TAP (splice)
  - 1. For copper-to-copper tapping splicing or pigtail.
  - 2. Wide wire range-taking capability minimizes inventory requirements.



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3. Color-coded for proper crimp die selection.
4. Ribbed design provides high strength.
5. Made from high conductivity wrought copper.
6. Tin-plated to inhibit corrosion and oxidation.
7. UL Listed and CSA Certified with AWG conductor to 600 V and temperature rated to 90°C when crimped with Panduit and specified manufacturers' crimping tools and dies.
8. CTAPF Series,
  - a. Panduit C-TAPs. Selected according AWG size of conductors being spliced
9. Main Run 6-4 AWG - Tap 6 AWG
  - a. Hubbell Part Number HYC4C6
10. Main Run 6-4 AWG – Tap 4 AWG
  - a. Hubbell Part Number HYC4C4
11. Main Run 2 AWG – Tap 8-4 AWG
  - a. Hubbell Part Number HYC2C4
12. Main Run 2 AWG – Tap 2 AWG
  - a. Hubbell Part Number HYC2C2
13. Main Run 1/0-2/0 AWG – Tap 8-2 AWG
  - a. Hubbell Part Number HYC26C2
14. Main Run 1/0-2/0 AWG – Tap 1/0-2/0 AWG
  - a. Hubbell Part Number HYC26C26

G. Code/Flex Conductor H-TAPs

1. Used to tap into continuous conductors as a splice or pigtailling.
2. Each HTAP terminates a wide range of conductor sizes and combinations of code and flex conductors Class G, H, I and Locomotive to suit a variety of applications.
3. Slotted design allows quick and easy assembly of conductor to HTAP using
4. Three Panduit 94V-0 cable ties included.
5. Tap grooves are separated from one another allowing them to function independently so HTAP can be used with a single or multiple taps providing maximum design and installation flexibility.
6. Color coded and marked with Panduit die index numbers for proper crimp die selection.
7. UL Listed and CSA Certified with AWG conductor for applications up to 600 V when crimped with Panduit and specified manufacturers' crimping tools and Panduit crimping dies.
8. Tin plated to inhibit corrosion.
9. Come available with an assortment of clear covers with integrated label fields.
10. H-Tap with cover
  - a. Burndy YH292CWC



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11. Main Run 4/0-2 AWG - Tap 2-8 AWG
  - a. Hubbell Part Number HYH292C
12. Main Run 2-8 AWG – Tap 2-8 AWG
  - a. Hubbell Part Number HYH2C2C
13. Main Run 6-10 AWG – Tap 6 AWG
  - a. Hubbell Part Number HYH6C6C
14. HTCT Series
  - a. Panduit HTAPs. Selected according AWG size of run and tap conductors
15. CLRCVR Series,
  - a. Panduit clear covers for HTAPs. Selected according to HTAP being covered.

H. Busbar Tap

1. Bubsar thickness 0.25", Main Run 2 AWG - Tap 6 AWG
  - a. Hubbell Part Number HYG14B2TC2C6C
2. Bubsar thickness 0.25", Main Run 2 AWG – Tap 2 AWG
  - a. Hubbell Part Number HYG14B2TC2C2C
3. Bubsar thickness 0.25", Main Run 4/0 – 1/0 AWG
  - a. Hubbell Part Number HYGBTC28

2.8 GROUNDING BUSBARS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Harger Lightning and Grounding.
    - a. TMGB: Harger P/N GBI14420TMGBKT
    - b. TGB: Harger P/N GBI14212TGBKT
  2. Chatsworth Products, Inc.
    - a. TGB: Chatsworth Part Number: 13622-012
    - b. TMGB: Chatsworth Part Number: 40153-020
  3. Hubbell
- B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches (6.3 by 100 mm) and at minimum 20 in cross section, length as indicated on Drawings. Increase length as necessary to provide all connections with 25% spare capacity. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-C.



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1. A TMGB shall be provided at the telecommunications service entrance (or as indicated on the drawings).
  2. Predrilling shall be with holes for use with lugs specified in this Section.
  3. Mounting Hardware: Stand-off brackets that provide a 4-inch (100-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel
  4. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50 mm) 12 in cross section, and at a minimum of 12-inches long or as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-C.
1. Predrilling shall be with holes for use with lugs specified in this Section.
  2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch (50-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
  3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- D. Telecommunications Bonding Backbone (TBB) Grounding Conductors:
1. To be bare or insulated copper, of minimum conductor size #6 AWG and sized at 2 kcmil per linear foot up to a maximum size of 750 kcmil.
  2. Where un-insulated, to be identified with green tape at termination location.
  3. Labeled in accordance with recommendations set forth in ANSI/TIA-606-C Administration Standard for Telecommunications Infrastructure.
  4. Owner approved manufacturers:
    - a. Southwire
    - b. Owner approved equivalent
- E. Bronze Bonding Pipe Clamps:
1. Used to ground copper code conductor to water pipe or copper tube.
  2. Cast from high strength, electrolytic bronze to provide reliable grounding connections.
  3. Plated steel screws providing high strength and inhibit corrosion.
  4. UL Listed for grounding and bonding with AWG conductor size and suitable for direct burial or encasement in concrete.
  5. Owner approved manufacturers:
    - a. Panduit
    - b. Owner approved equivalent
  6. Part numbers:
    - a. KP1-C; For pipe range 1/2 – 1" inch and conductor size range #10 SOL - #2 STR
    - b. KP2-L; For pipe range 1 1/4 – 2 and conductor size range #10 SOL - #2 STR
- F. Bronze Bonding Clamps for Conduit:



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1. Used to ground copper conductor parallel or at a right angle to a rod, tube, or pipe.
2. Made from high strength, electrolytic cast bronze.
3. High strength silicon bronze hardware provides long term reliable assembly.
4. Accommodates a wide range of pipe, tube, rod and conductor sizes – minimizes inventory.
5. UL Listed for grounding and bonding with AWG conductor and suitable for direct burial in earth or concrete.
6. Owner approved manufacturers:
  - a. Panduit
  - b. Owner approved equivalent
7. Part numbers:
  - a. GPL-8-Q; For pipe size inches 1/2 or 3/4 and conductor size range AWG #8 SOL - #4 SOL
  - b. GPL-14-X; For pipe size inches 1 and conductor size range AWG #8 SOL - #4 SOL
  - c. GPL-22-X; For pipe size inches 1 1/4 and conductor size range AWG 2/0 SOL – 250 kcmil
  - d. GPL-28-X; For pipe size inches 1 1/2 and conductor size range AWG 2/0 SOL – 250 kcmil
  - e. GPL-34-3; For pipe size inches 2 and conductor size range AWG 2/0 SOL – 250 kcmil

G. Communication Grounding Rods:

1. Material: Copper-clad steel.
2. Size: 3/4-inch by 8 to 10 feet long.
3. Standards: Meet requirements of ANSI/UL 467-1984, CSA, and ANSI/NEMA GR-1.
4. Owner approved manufacturers:
  - a. Erico
  - b. Burndy
  - c. T&B
  - d. Lyncole
  - e. Owner approved equivalent

H. Electrolytic Ground Rods:

1. Where standard ground rods do not have acceptable levels of conductivity (typically greater than 5 ohms resistance) to earth due to local soil conditions, electrolytic systems may be considered.
2. Such systems shall meet the following:
  - a. Be comprised of a hollow stainless steel or copper tube 10 feet or longer and filled with a mixture of hygroscopic electrolytic salts.
  - b. Function as an active grounding system by absorbing moisture out of the air and constantly leaching and electrolytic solution into the surrounding soil to maintain high conductivity.



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- c. Rod shall be encased in a conductive, non-corrosive carbon based back fill material.
- d. Provide low resistance to ground.
- e. Provide season to season stability.
- f. Be maintenance-free for 30 years.
- g. Contain no hazardous materials or chemicals.

I. IEEE Universal Beam Grounding Clamp

- 1. For bonding structural steel (ex: I-beams) into bonding network
- 2. Universal, fits on a wide range of standard (angled) and wide flange (parallel) structural steel beams.
- 3. Provide a mounting pad suitable for a two-hole compression lug.
- 4. Install quickly and easily with standard 1/4" inch key hex wrench tooling.
- 5. UL 467 Listed and CSA 22.2 Certified for grounding and bonding suitable for direct burial in earth or concrete.
- 6. Comply with vibration tests per MIL-STD-202G (METHOD 201A).
- 7. Owner approved Manufacturers for beam grounding clamps:
  - a. Panduit
  - b. Owner approved Equivalent
- 8. Part Number:
  - a. GUBC500-6, Panduit Universal Beam Grounding Clamp for copper conductor sizes ranging from #AWG to 500kcmil and flange thickness from 0.25" inch to 0.675" inch. Stud size is 1/2" inch with hole spacing for two-hole lug being 1.75" inch and thread size from 1/2 to 13.

J. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-C. Predrilling shall be with holes for use with lugs specified in this Section.

- 1. Rack-Mounted Vertical Busbar: Minimum 36-inches long with stainless-steel or copper
- 2. Provides clean bond to any rack mounted equipment regardless of whether or not equipment has an integrated grounding terminal.
- 3. Bonds up to 45 RU per rack.
- 4. Comes in EIA universal mounting hole pattern.
- 5. Complies with US and International grounding requirements.
- 6. Comes in threaded rail and cage nut versions.
- 7. Plated hardware for attachment to the rack. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
  - a. Chatsworth Part number:40161-0XX
- 8. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.



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- a. Chatsworth 19" Part number: 10610-019
- b. Chatsworth 23" Part number: 10610-023
- c. Panduit RG S134-1Y, Grounding strip for threaded rails: 78.65" inch (2m) length: 67" inch (17mm) width: 0.05" inch (1.27mm) thickness; provided with 16 oz. (5cc) of antioxidant, one grounding sticker and three each #12-24 x ½" inch and M6 x 12mm thread-forming screws
- d. Panduit RG S134B-1, Grounding strip for use with cage nut rail fasteners: 78.70" inch (2m) length: 67" inch (17mm) width: 0.05" inch (1.27mm) thickness: provided with. 16oz (5cc) of antioxidant, one grounding sticker, three cage nut bonding studs, eight #12-24 bonding nuts and three strip clips

K. Rack Bonding Conductor Kits (RBC)

- 1. Bonds the rack or cabinet to the telecommunications grounding busbar (TGB).
- 2. Jumper kit available with both ends factory terminated to provide a bolt-on solution.
- 3. Jumper kit available with one end factory terminated to attach to the rack or cabinet; free end accommodates unique length requirements.
- 4. Engineered to comply with US and international grounding requirements.
- 5. Owner approved Manufacturers:
  - a. Panduit
  - b. Owner approved equivalent
- 6. Part Numbers:
  - a. GJ672UH, Terminated on both ends for smaller telecommunications rooms where racks have individual connections directly to the TMB. One 72" inch length #6 AWG green wire with yellow horizontal stripe. Jumper is pre-terminated on one end with LCC6-14JAWH-L and the other end with LCC6-14JAW-L. Comes in lengths 72" inch, 96" inch, 120" inch, 144" inch, 168" inch, 192" inch, 216" inch, 240" inch, 264" inch, and 288" inch. For other lengths substitute 72" inch in part number with desired length
  - b. GJS6120U, Terminated on one end for larger telecommunications rooms where racks are individually bonded to underfloor or overhead bonding backbone with an HTAP connection. One 120" inch length #6 AWG green wire with yellow horizontal stripe. Jumper is pre-terminated on one end with LCC6-14JAW-L. For 180" inch length substitute "120" inch in part number with "180"
  - c. HDW1/4-KT, Stainless steel mounting hardware for busbar; two 1/4-20 hex bolts, two 1/4-20 hex nuts, four 1/4 flat washers and two 1/4 Belleville compression washers. Mounting hardware for rack or cabinet; two #12-24 thread-forming screws and two M6 thread-forming screws.
  - d. HDW3/8-KT, Stainless steel mounting hardware for busbar; two 3/8-16 hex bolts, two 3/8-16 hex nuts, four 3/8 flat washers and two 3/8 Belleville compression washers. Mounting hardware for rack or cabinet; two #12-24 thread-forming screws and two M6 thread-forming screws
  - e. HDW1/4-A-KT, Stainless steel mounting hardware for busbar; two 1/4-20 hex bolts, two 1/4-20 hex nuts, four 1/4 flat washers and two 1/4 Belleville



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- compression washers. Mounting hardware for rack or cabinet; two #10-32 thread-forming screws and two M5 thread-forming screws
- f. HDW3/8-A-KT, Stainless steel mounting hardware for busbar; two 3/8-16 hex bolts, two 3/8-16 hex nuts, four 3/8 flat washers and two 3/8 Belleville compression washers. Mounting hardware for rack or cabinet; two #10-32 thread-forming screws and two M5 thread-forming screws

L. Electrostatic Discharge (ESD) Port Kits and Wrist Strap

1. For dissipating electro-static buildup prior to maintenance work on network equipment.
2. Accommodate standard ESD wrist strap 4mm plug.
3. Wrist strap provides rapid and continuous drain of electrostatic charge between a person and the surface that the wrist strap is bonded to, thus preventing damaging static discharge into equipment.
4. Can be mounted to front or back of rack or cabinet for convenient access.
5. Bent 45°, acts as a hook to hold wrist strap.
6. Two-hole configuration provides anti-rotation and prevents loss of bond.
7. Barrel permanently marked with the protective earth (ground) symbol.
8. Engineered to comply with US and International grounding requirements.
9. Versions for threaded racks rails or cabinet cage nuts.
10. Owner approved Manufacturers:
  - a. Panduit
  - b. Owner approved equivalent
11. Part Numbers:
  - a. RGEDS2-1, For #12-24 or M6 rail fasteners: Two-hole ESD port with 5/8" inch hole spacing; provided with an ESD protection sticker, .16 oz. (5cc) of antioxidant, and two each #12-24 x 1/2" inch and M6 x 12mm thread-forming screws
  - b. RGEDS2B-1, For cage nut rail fasteners: Two-hole ESD port with 5/8" inch hole spacing; provided with an ESD protection sticker, .16 oz. (5cc) of antioxidant, two cage nut bonding studs and two #12-24 bonding nuts
  - c. RGEDWS, Adjustable fabric ESD wrist strap with 6' coil cord, banana plug, 1 meg ohm resistor and 4mm snap.

M. Equipment Jumper Kits (Unit Bonding Conductor or "UBC")

1. Ground large rack mounted equipment that has built-in grounding pads or terminals.
2. Bond network equipment to grounding strip or grounding busbar.
3. Jumper kit available with both ends factory terminated to provide a bolt-on solution.
4. Jumper kit available with one end factory terminated to attach to the grounding strip or grounding busbar; free end accommodates unique equipment terminations.
5. Use jumpers with 90° bent lug, on grounding strip side, for high density grounding requirements up to one ground point per RU.



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6. Use jumpers with 45° bent lugs, on grounding strip side, for improved cable management.
7. Engineered to comply with US and International grounding requirements.
8. Owner approved Manufacturers:
  - a. Panduit
  - b. Owner approved equivalent
9. Part Numbers:
  - a. GJS6 series, #6 equipment jumper factory terminated on one end for switches, cabinets and 4 post racks. Exact part number depends on length
  - b. RGE series, Equipment factory terminated jumpers terminated on both ends. Exact part number depends on AWG size, length and angle of two hole lugs

N. Surge Suppressor Jumper Kit

1. Bonds power or data line surge suppressor to grounding strip or grounding busbar.
2. Both ends factory terminated to provide a bolt-on solution.
3. Engineered to comply with US and International grounding requirements.
4. Owner approved Manufacturers:
  - a. Panduit
  - b. Owner approved equivalent
5. Part Number:
  - a. SSGK-1, #10 AWG (6mm<sup>2</sup>) jumper; 24" inch (.61m) length; factory terminated on both ends; one-hole lug on surge suppressor to two-hole lug on grounding strip/busbar side; provided with .16 oz. (5cc) of antioxidant and two each #12-24 x 1/2" inch, M6 x 12mm, #10-32 x 1/2" inch and M5 x 12mm thread-forming screws

O. Armored Cable Grounding Kit

1. To be used in conjunction with the Corning Armored Cable Grounding Kit:
  - a. FDC-CABLE-GRND, Armored Cable Grounding Kit; contains armored grounding clip and ground strap
2. Provides a secure bond to the armor sheath on indoor and indoor/outdoor fiber optic cables at both cassette and enclosure ends.
3. Worm-gear design evenly distributes forces across the armor
4. Made from steel and aluminum material is compatible with common armor for long term reliability.
5. Black insulating cover protects and hides the connection for an aesthetically pleasing work area.
6. Complies with industry requirements ensuring a high level of reliability and safety.
7. Owner approved Manufacturers:
  - a. Panduit
  - b. Owner approved equivalent



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8. Part Numbers:
  - a. ACG24K, #6 AWG (16mm<sup>2</sup>) jumper for armored cable diameter up to 0.84" inch (21.3mm); 24" inch (609.6mm) length; factory terminated on one end with LCC6 two-hole copper compression lug and the other end with grounding terminal; provided with two each #12-24 and M6 thread-forming screws and a black polypropylene terminal cover
  - b. ACG24K-500, #6 AWG (16mm<sup>2</sup>) jumper for armored cable diameter 0.85" inch (21.3mm) to 1.03" inch (26.2mm); 24" inch (609.6mm) length; factory terminated on one end with LCC6 two-hole copper compression lug and the other end with grounding terminal; provided with two each #12-24 and M6 thread-forming screws and a black polypropylene terminal cover
  - c. ACGK, Armored cable grounding kit with one grounding terminal for #6 AWG and one #10 mechanical clamp, 9/16" inch – 1 1/16" inch diameter range

P. Miscellaneous Bonding Accessories:

1. Anti-oxidation Paste For Copper to Copper and Copper to Steel Connections
2. Green thread-forming bonding screws for bonding smaller equipment on threaded rack rails.
3. Green bonding cage nuts from bonding smaller equipment on cage nut rails.
4. Thread forming screws for bonding two hole lugs to vertical busbars on threaded rack rails.
5. Green paint piercing grounding washers for assuring electrical continuity between painted parts of equipment racks as described in TIA 607-D Standard.
6. Bonding hardware kits (studs) for forming low-resistance bond between the rack or cabinet and painted rack mounted appliances and equipment.
7. Owner approved Manufacturers:
  - a. Panduit
  - b. Owner approved equivalent
8. Part Numbers:
  - a. CMP-300-1, Contact aid for copper-to-copper and copper-to-steel connections, 8 oz. Operating temperature range -40°F (-40°C) to 350°F (177°C). Good for all voltages and suitable for grounding. Also used for anti-seizing thread lubricant
  - b. RGTBSG-C, Green thread-forming bonding screw, #12-24 x 1/2" inch for mounting smaller equipment and bonding to rack/cabinet racks through equipment mounting flange
  - c. RGTBS1032G-C, Green thread-forming bonding screw, #10-32 x 1/2" inch for mounting smaller equipment and bonding to rack/cabinet racks through equipment mounting flange
  - d. CNB4K, Green bonding cage nut, includes 4 #12-24 bonding cage nuts (.06 – .11 thick panel) and 4 #12-24 x 1/2" inch bonding screws with #2 Phillips/slotted combo hex head (use 5/16" or 8mm socket). Ideal for patch panel applications
  - e. CNBK, Green bonding cage nut, includes 4 #12-24 bonding cage nuts (.06 – .11 thick panel) and 4 #12-24 x 1/2" inch bonding screws with #2



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Phillips/slotted combo hex head (use 5/16" inch or 8mm socket). Ideal for patch panel applications

- f. RGTS-CY, Thread-forming grounding screw, #12-24 x 1/2" inch for bonding two-hole grounding lugs to rack/cabinet vertical busbars
- g. RGTS1032-C, Thread-forming grounding screw, #10-32 x 1/2" inch for bonding two-hole grounding lugs to rack/cabinet vertical busbars
- h. RGW-100-1Y, 100 paint piercing bonding washers for 3/8" inch (M8) stud size; .875" inch (22.2mm) O.D.; provided with .16 oz. (5cc) of antioxidant
- i. TRBSK, Bonding stud kit for threaded #12-24 rail fasteners; includes 25 bonding studs and 50 bonding nuts for bonding painted equipment and appliances to rack/cabinet rails and vertical busbars
- j. CGNSK, Bonding stud kit for cage nut rail fasteners; includes 25 bonding studs and 50 bonding nuts for bonding painted equipment and appliances to rack/cabinet rails and vertical busbars
- k.

## 2.9 LADDER RACK BONDING CONDUCTORS

### A. Ground cord assembly

- 1. Stranded THHN
- 2. Color: green
- 3. #6 AWG insulated bonding jumper
- 4. Length: 9" - 12".
- 5. Each end terminated with a two-hole compression lug or listing approved terminal
- 6. Hubbell
  - a. Part Numbers HGRKTD12D, HGRKTKA9KA5, HGRKTKLU9KLU5

### B. Braided Jumper

- 1. 0.94" Braid width
- 2. Hole diameter 0.375"
- 3. Hole Spacing 1.25"
- 4. Length: 12"
- 5. Hubbell Part Number HGBBD12

### C. Split Bolt for Bonding Cable Trays:

- 1. Made from high strength copper alloy to resist corrosion and provide premium electrical and mechanical performance.
- 2. Wire range-taking capability minimizes inventory requirements.
- 3. Nut hex provides correct fit with socket, box, or open end wrenches resulting in proper torqueing of electrical connection.
- 4. Pressure bar provides secure connection on a full range of conductor combinations used with each connector assuring premium wire pull-out strength.
- 5. UL Listed and CSA Certified with AWG conductor for use up to 600 V and temperature rated 90°C.



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6. Be available in tin-plated version for bonding to galvanized wire baskets and Flex Tray.
7. Owner approved Manufacturers:
  - a. Panduit
  - b. Owner approved equivalent
8. Part Numbers:
  - a. SBC3-C, Panduit split lug for #8AWG to #4AWG code conductors
  - b. SBCT3-C, Panduit split lug for #8AWG to #4AWG code conductors – tinned for use with galvanized basket tray delivery systems

D. Auxiliary Cable Brackets (Conductor Pathway)

1. Used for mounting telecommunications bonding conductors outside of cable tray.
2. Maintain minimum 2" inch separation between bonding conductors and other types of cabling per TIA 607-C.
3. Bonds ladder rack, wire basket sections together without drilling holes or applying other split-bolt clamps.
4. Supports grounding conductors in the telecommunications room, allows separation of grounding conductors from other cables.
5. Holds up to four conductors in sizes up to 750 kcmil.
6. Bonds to 1" inch and 2" inch ladder rack rails.
7. Paint piercing teeth provide electrical continuity between cable pathway sections while minimizing debris.
8. Front and back mounting screw options allow easy installation and visual inspection.
9. Mounted above or below the cable pathway system for flexibility.
10. Meet requirements TIA-607-C.
11. Have available bonding jumper kits to bond sections of basket tray or ladder rack.
12. Part Numbers:
  - a. Panduit GACB-2, Auxiliary cable bracket; 1.63" inch (41.4mm) width, 3.95" inch (100.3mm) height, 5.22" inch (132.6mm) depth; provided with on mounting screw.
  - b. Panduit GACBJ612U, Auxiliary cable bracket jumper for bonding pathway sections: #6AWG (16mm<sup>2</sup>); 12.0" inch (305mm) length; factory terminated on both ends with straight, two-hole, long barrel compression lugs; provided with .16oz. (5cc) of antioxidant and four mounting s screw.
  - c. Hubbell: HGBKS17, HGRKTWC45, HGRKTWB5

E. Wall-mount Busbars (TGB and TMGB and labeling):

1. Meet BICSI and TIA-607-C requirements for network systems grounding applications.
2. Employ BICSI hole spacing.
3. Be made of high conductivity copper and tin-plated to inhibit corrosion.
4. Come pre-assembled with brackets and insulators attached for quick installation.
5. Use Panduit component labels, sold separately, to identify busbars to meet TIA/EIA-606-C.



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6. Owner approved Manufacturers:
  - a. Panduit
  - b. Owner approved equivalent
7. Part Numbers:
  - a. GB2B0306TPI-1, Telecommunications grounding busbar (TGB) with 6 number of mounting positions with 1/4" inch stud hole with 5/8" inch hole spacing and 3 number of position with 3/8" inch stud hole with 1" inch hole spacing
  - b. GB2B0312TPI-1, Telecommunications grounding busbar (TGB) with 12 number of mounting positions with 1/4" inch stud hole with 5/8" inch hole spacing and 3 number of position with 3/8" inch stud hole with 1" inch hole spacing
  - c. GB4B0624TPI-1, Telecommunications main grounding busbar (TMGB) with 24 number of mounting positions with 1/4" inch stud hole with 5/8" inch hole spacing and 6 number of position with 3/8" inch stud hole with 1" inch hole spacing
  - d. GB4B1028TPI-1, Telecommunications main grounding busbar (TMGB) with 28 number of mounting positions with 1/4" inch stud hole with 5/8" inch hole spacing and 10 number of position with 3/8" inch stud hole with 1" inch hole spacing
  - e. LTYK, Busbar label kit includes one printed tag and on flame retardant cable tie

## 2.10 LABELING

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Brady Part number: HSA-64
- C. Comply with TIA-606 and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- D. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Locate TMGB and TGBs so that they are accessible to telecommunications personnel.
- B. At a minimum, follow all manufacturer instructions. In case of discrepancy between manufacturer and contractor requirements, the more stringent shall apply. In the case



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of conflicting instructions, report any discrepancy to the Design Engineer in a timely fashion so as not to impact the construction timeline.

- C. At a minimum, provide exothermic welds as identified on the drawings or required in the specifications. For all other connections, irreversible compression connections are Sufficient
- D. Contractor is responsible for furnishing and installing a Telecommunications Grounding Busbar (TGB) at all new equipment racks and cabinets per design documents. Each rack mounted TGB shall be bonded to the TGB that has been installed in the room.
- E. A # 6 conductor shall be bonded to each rack mounted TGB, then coiled and stored neatly at each rack for future use.
- F. Contractor is responsible for bonding sections of cable tray together utilizing #6 grounding (earthing) straps, then installing a # 6 grounding (earthing) conductor between the tray and the TGB that has been installed in the room.
- G. If grounding (earthing) must be applied to a location where bare metal is not exposed, the covering (e.g. paint) shall be fully removed to expose bare metal and facilitate bonding. At each such bonding point, no greater than 12 mm (.5 in) and no less than 6 mm (.25) in of exposed metal shall remain after bonding is completed.
- H. Where armored cable is deployed, it shall be bonded to ground (earth) at one end in accordance with AHJ and in accordance with the manufacturer's guidelines.
- I. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.
- J. All work shall comply with applicable safety rules and regulations including OSHA and state safety regulations. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.
- K. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- L. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- M. The complete earthing systems shall be complete from the grounding electrode(s) to each point of connection to telecommunication, network or server equipment or metal component surface.



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- N. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.
- O. Install the grounding and bonding system in a manner ensuring that communications circuits, when installed, are able to fully comply with the ANSI/TIA and other references listed in Part 1 — References, above.
- P. All bonding conductors shall be insulated and copper. The minimum bonding conductor size shall be #6 AWG. The telecommunications bonding conductor shall be sized in accordance with Table 1 below from TIA-697B. All conductors #6 AWG and smaller shall be provided with green-colored insulation.



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Q.

**TABLE 1**

Sizing of the TBB	
TBB length in feet (meters)	TBB Size (AWG)
Less than 13 (4)	6
14-20 (4-6)	4
21-26 (21-26)	3
27-33 (27-33)	2
34-41 (34-41)	1
42-52 (42-52)	1/0
53-66 (53-66)	2/0
67-84 (67-84)	3/0
85-105 (85-105)	4/0
106-125 (106 – 125)	250 kcmil
126-150 (126-150)	300 kcmil
151-175 (151-175)	350 kcmil
176-250 (176-250)	500 kcmil
251-300 (251-300)	600 kcmil
Greater than 301 (91)	750 kcmil

- R. The grounding and bonding infrastructure system shall not make use of the building plumbing system, unless required to do so by the NEC.
- S. The entire grounding path from each final equipment connection to earth shall be able to be inspected visually.
1. EXCEPTION: Where indicated on drawings to be direct-buried in earth or within walls or raceways.
- T. Coordinate the installation of the grounding and bonding system with the electrical power distribution system grounding infrastructure.
- U. Where a telecommunications metal pathway or raceway contains an expansion joint, each side of the expansion fitting or gap shall be bonded to provide an electrically continuous path to ground.



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- V. The system shall provide an equipment ground connection (bonds) from the premises entrance facility and outside-plant earthing system to each telecommunication room telecommunication ground busbar, through the racking systems to bond the network equipment.
- W. Label elements of the communications bonding network according to guidelines defined in TIA-607 and ANSI/TIA 606.
- X. Contractor shall be completely responsible for the installation and testing of the complete grounding and earthing system and shall be knowledgeable of all standards, codes, installation and testing methods of those systems. The system delivered to the Owner shall be a fully functioning, standards-compliant earthing system and shall be free of any conflicts or discrepancies.

### 3.2 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

### 3.3 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with TIA-607.
- D. Where practicable, install telecommunication bonding, telecommunication bonding backbone conductors, telecommunications bonding backbone interconnecting bonding conductors, equipment bonding conductor and all other grounding and bonding conductors in a manner so they are routed horizontal to and downward toward the grounding electrode for the telecommunication bonding system.
- E. Install all bonding and grounding cabling such that no bend forms an included angle of more than 90 degrees or has a radius of less than 8".



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- F. Maintain a minimum distance of 12" between any bonding or grounding conductor and any direct-current power cabling, electrical service entrance or feeder cables, or any high-frequency cabling, even where such conductors or the bonding conductors are enclosed in metallic conduit.
- G. Avoid placing bonding conductors in ferrous metallic conduit. Where necessary to place bonding conductors in ferrous metallic conduit that exceeds 3 ft. in length, each conductor shall be bonded to each conduit end with approved fittings and minimum #6 AWG bonding conductor to each conductor.
- H. All bonding conductors shall be continuous and routed in the shortest possible path and at right angles to building lines, unless noted or indicated otherwise.
- I. Where routed along cable tray pathways, install telecommunication bonding backbone cable or bonding conductors on underside and at edge of tray nearest the most common access area. Fasten to tray with approved "L" connectors at not less than 36" intervals.
- J. Where routed along open pathways utilizing hooks or straps, install telecommunication bonding backbone cable or bonding conductors below telecommunication backbone cabling and so bonding cable is accessible from below. Fasten to hangar support with approved connector at not less than 36" intervals.
- K. Grounding conductors shall not decrease in size as the earthing path moves toward the grounding electrode.
- L. Splices within a Telecommunication Bonding Backbone (TBB) shall not be permitted without prior approval of the Designer. Taps from the TBB riser to lateral TBB conductors and where otherwise indicated on the Drawings shall be permitted. All such taps shall utilize irreversible compression-type connectors, exothermic welding or an approved equal connection method. All joints shall be adequately supported and protected from damage.
- M. Whenever two or more vertical TBBs are used in a building, the TGBs shall be interconnected at the top of each riser and at every third floor with a Telecommunications Bonding Backbone Interconnecting Bonding Conductor (TBBIBC), in accordance with ANSI/TIA/EIA-607 and the NEC.
- N. Each telecommunications bonding conductor shall be marked appropriately by a distinctive green color. Where conductor insulation is other than green in color, securely mark each conductor with color-coded green marking tape within 6 inches of each termination or point of connection; and where conductor is not installed in conduit, at a minimum of 8 foot intervals to provide ready identification.
- O. Each telecommunications bonding conductor shall be labeled. Labels shall be located on conductors as close as possible to point of termination and be oriented so they may be easily read. Labels shall nonmetallic and include at a minimum the following text "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE



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OR DISCONNECT!" Label each TMGB with "TMGB" and each TGB with "TGB". Refer to Drawings for additional labeling instructions.

### 3.4 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
  - 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
  - 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.
- C. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.
- D. Conductor Support:
  - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm).
- E. Grounding and Bonding Conductors:
  - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
  - 2. Install without splices.
  - 3. Support at not more than 36-inch (900-mm) intervals.
  - 4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
    - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 27 05 28 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.
- F. Telecommunication Space Grounding



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1. Racks and cable tray systems shall be grounded separately with dedicated conductors.
2. Conductors shall be minimum #2/0 AWG rubber-coated flexible welding-type cable.
3. Cable trays may be grounded at one location.
4. All grounding lugs shall be compression-style, 2-hole lugs.
5. Cables containing metallic shield or armor shall be properly bonded into the communications grounding system using the appropriately sized armored cable grounding kit listed in the Products section of this document.
6. Each telecommunications room shall be served by at least one (1) dedicated TGB located within that room or space.
7. Within each room the following items at a minimum shall be connected to the TGB within that room.
  - a. Exposed building steel
  - b. Equipment racks and cabinets
  - c. Cable tray and metal pathways
  - d. Telecommunication Equipment Bonding Conductors (TEBC)
  - e. Telecommunication Bonding Backbone (TBB)
8. In smaller Telecommunications Rooms with only 3 to 5 racks it is acceptable to have individual rack bonding conductors (RBC) go directly to the TGB. Daisy chaining of racks will not be accepted.
9. Telecommunications Rooms and Telecommunications Grounding Busbar (TGB)
  - a. The TGBs shall have a tinned surface to inhibit oxidation and be sized according to the anticipated number of bonded connections that will be needed.
  - b. TGBs shall be sized according to the anticipated number of bonded connections needed.
  - c. TMGs shall have tinned surfaces to restrain oxidation and be cleaned and antioxidant paste applied prior to fastening conductors.
  - d. Connectors on backbone and rack/cabinet bonding conductors which attach to TGB shall be of two-hole, long-barrel compression lugs of the LCC series.
  - e. Bond the building steel within six feet of the communications grounding system.
  - f. Racks and cabinets shall have individual Rack Bonding Conductors bonding to the Telecommunications Equipment Bonding Conductor (TEBC) or underfloor Supplemental Bonding Grid. Daisy chaining or serial connections of one rack cabinet to another will not be accepted.
  - g. Rack Bonding Conductors (RBC) or above rack row grounds (TEBC) shall be installed to maintain a minimum of 2" inch separation from cable, power or communications.
  - h. Install auxiliary conductor brackets to maintain the segregation of cables in Telecommunications rooms may lend themselves to the installation of Auxiliary Conductor Brackets for routing bonding conductors outside of, yet parallel to ladder rack or basket tray.
  - i. Bonding conductor support systems like auxiliary brackets shall be spaced no further apart than three foot intervals.



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- j. This illustration below depicts general location and layout of the telecom room and associated bonding connections into the TGB.

G. Wire Basket Trays

- 1. Ground as specified on drawings

H. Grounding of Rack Rows in Telecommunication spaces

- 1. Contractor shall provide (1) #2/0 AWG dedicated main grounding conductor above each rack attached to the wire basket tray or unistrut structure above the rack row.
- 2. Provide (1) #6 Green solid insulated conductor from the #2/0 main conductor into the rack or cabinet below.
- 3. Provide compression-style H-tap with cover and connect #2/0 and #6 together.
- 4. Connect #6 to cabinet or rack with compression-style 2-hole straight barrel lug. Remove all paint to ensure reliable connection.
- 5. Provide separate #6 bonding jumper for each rack or cabinet to #2/0 main conductor.
- 6. No series connections (daisy-chaining) of grounds are allowed.
  - a. Provide additional 19" horizontal rack busbar in each 4-post rack installed. Install at top rear of each 4-post rack. Provide #6 AWG bonding jumper from busbar to rack rail (at same location #6 to overhead #2/0 AWG is connected.)
  - b. This bonding conductor shall be separate, apart and addition to bonding conductors for cable trays, basket trays, building steel or other grounded metal objects.
- 7. Grounding busbars
  - a. Connection of conductors bonding telecommunication equipment to the telecommunications busbar (TMGB or TGB) shall utilize two-hole compression-type lugs, unless noted otherwise.

3.5 GROUNDING OF EQUIPMENT AND MATERIALS

- A. Within each room or space containing a TMGB or TGB, all metallic raceways for communication cabling shall be bonded to the TMGB or TGB.
- B. Within each telecommunication room, entrance facility, equipment room or other telecommunication space, bond all equipment racks and cabinets, all ladder racks and cable trays, and all other materials or equipment identified as requiring bonding on the Drawings, to the TGB or TMGB within that space.
- C. Remove paint to bare metallic surface for all painted surfaces at point of bonding.
- D. Where a backbone cable incorporates a shield or metallic member, such shield or metallic member shall be connected to the TMGB or TGB. Approved fittings and methods shall be used for connection to the shield or metallic member to the grounding conductor.



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- E. The metallic sheath of outside plant (OSP) communication cables entering a building shall be grounded as close as practicable to the point of entrance or shall be interrupted as close to the point of entrance as practicable by an insulating joint or equivalent device.
- F. The point of entrance shall be considered to be at the point of emergence through an exterior wall, a concrete floor slab, or from a grounded rigid metal conduit or an intermediate metal conduit grounded to an electrode in accordance with Section 800-40(b). See NEC Article 800, "Communications Circuits".
- G. Contractor shall bond the cable shield to the TMGB or to the protection frame ground as indicated.
- H. Bonding within Racks and Cabinets
  - 1. Racks and Cabinets shall be bonded into the communications bonding network with conductors of #6 AWG or larger.
  - 2. Depending on size of the telecommunications room, Rack Bonding Conductors (RBC) may bond to underfloor or overhead grounding conductors, or for smaller TRs 4-5 racks or less, may go directly from the rack to the wall mounted busbar.
  - 3. Racks, cabinets and similar enclosures shall not be bond serially or daisy-chained. Bond racks and cabinets with an RBC to the grounding system.
  - 4. Newly installed racks and cabinets shall have vertical grounding busbars installed along one rail to provide a clean bonding landing point for rack mount equipment.
  - 5. Painted components of racks/cabinets shall be assembled using serrated grounding washers and thread-forming screws as per TIA 607 to ensure electrical continuity between the different parts of the rack/cabinet.
  - 6. Larger equipment, such as chassis switches, with integral grounding terminals or pads shall be bonded to the vertical busbar with equipment grounding kits attached to those terminals, and bonding them to the rack-mounted busbars.
  - 7. Where two metallic surfaces are bonded together, clean the contact areas of paint or oxidation and apply film of anti-oxidation compound between surfaces prior to bonding.
  - 8. Cable fittings shall be of two hole (LCC series) compression-type. Mechanical screw-lugs on racking systems will not be accepted.
  - 9. Screws used to affix compression lugs to rack-mounted vertical busbars shall be of the thread forming type made specifically for electrical bonding.
  - 10. Smaller equipment such as servers, Top of rack switches, not having integral grounding pads are bonded to the rack through the equipment mounting flanges using green thread forming grounding screws with serrations under the head that are built to that purpose. Such equipment shall have minimally one grounding screw per piece of equipment.
  - 11. Provide ESD (electro-static discharge) ports and wrist straps every other rack or bay and to be within reach of any active equipment. On larger 4-post racks or cabinets - ESD ports and wrist straps shall be installed on the front and back to be accessible when servicing any active equipment.



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12. Technicians servicing active equipment to wear a properly grounded wrist strap to dissipate ESD charges prior to touching any Owner active equipment.
13. The following illustration demonstrates how the racks shall be bonded:

### 3.6 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 1/0 AWG. The BCT shall be, as a minimum, the same size as the largest TBB.
- B. The TBB between the TMGB and the farthest TGB shall be a continuous copper conductor that should be sized no less than 6 AWG to a maximum 3/0 AWG. This conductor shall be sized per Table 1 below:

TBB Conductor Size vs. Length	
TBB/GE linear length (ft.)	TBB/GE size (AWG)
Less than 4	6
14-20	4
21-26	3
27-33	2
34-41	1
42-52	1/0
53-66	2/0
Greater than 66	3/0

- C. The GE between TGBs on the same floor on the first, top, and every third floor in a multistory building shall be a continuous copper conductor that should be size no less than 6 AWG. The GE shall be, as a minimum, the same size as the largest TBB.
- D. The Telecommunications Equipment Bonding Conductor (TEBC) shall be a continuous copper conductor that should be sized no less than 6 AWG.

### 3.7 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 12 inches (300 mm) above finished floor unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

### 3.8 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.



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- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
  - 1. Use crimping tool and the die specific to the connector.
  - 2. Pretwist the conductor.
  - 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the TMGB with insulated bonding conductor.
- E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot (1 sq. mm/linear meter) of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted or vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.
- I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-D when grounding screened, balanced, twisted-pair cables.
- J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- K. Access Floors: Bond all metal parts of access floors to the TGB.
- L. Equipment Room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.



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1. Install the conductors in grid pattern on 4-foot (1200-mm) centers, allowing bonding of one pedestal from each access floor tile.
2. Bond the TGB of the equipment room to the reference grid at two or more locations.
3. Bond all conduits and piping entering the equipment room to the TGB at the perimeter of the room.

3.9 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- B. Comply with IEEE C2 grounding requirements.
- C. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- D. Grounding Connections to Manhole Components: bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.10 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
  1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
  2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
  3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"



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3.11 FIELD QUALITY CONTROL

- A. Refer to Section 27 00 00 "Communications" which identifies testing requirements for the Project.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Perform tests and inspections. Tests shall be performed by the contractor and the designer/consultant shall perform the inspections.
- D. Tests and Inspections:
  - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  - 2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
    - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
    - b. A copy of the test results shall be provided to the owner prior to any telecommunication services being activated.
  - 3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
    - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.
- E. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- F. Grounding system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Visually verify continuity of communications bonding system from equipment, through racking systems, to overhead or underfloor backbone to the wall mounted busbar in that telecommunications room.
- I. Verify the use of appropriate bonding accessories in the racking systems such as grounding washers, thread-forming grounding screws and the presence of electro-static discharge ports and wrist straps within reach of the equipment to be maintained.



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1. On Greenfield projects involving installation of a building-wide telecommunications backbone, visually verify the bonding system through to entrance facility and check for properly sized and installed grounding equalizer conductors between separate backbones as described earlier in this Section.
- J. During inspections contractor shall verify compliance with the requirements specified in this document and compliance with the regulatory references Standards and Codes cited.
- K. Opens or gaps in the bonding system during final inspections will be recorded and remedied.
- L. During inspections, check the grounding and bonding system conductors and connections for tightness and proper installation.
- M. Test 10 percent of the bonded connections within the grounding system for resistance. Tests on either side of a compression or exothermic bond shall be less than 0.2 ohms of resistance.
- N. Bonded joints to be tested to be randomly identified by a representative of the Owner.
- O. Test system at bonded points indicated and provides results in report form.
- P. Failing bonds shall be remedied by installation contractor at contractor's expense.

**END OF SECTION 27 05 26**



## **SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Raceways: Cable and basket trays, sleeves, surface raceways and inner ducts for Communication Systems installed aboveground either exterior to or within a building structure.
- B. Boxes: Outlet boxes, junction boxes and pull boxes for Communication Systems installed aboveground either exterior to or within a building structure.
- C. Other pathways: J-hooks and hangars for Communication Systems installed aboveground either exterior to or within a building structure.

#### **1.2 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. This Section includes product and execution requirements for items unique to communications and not included in Division 26 Sections.
- C. Refer to Section 26 05 33 "Raceway and Boxes for Electrical Systems" - Part 1 for requirements for Standards, Submittals, Quality Assurance, Delivery/Storage/Handling, and Guarantee for:
  - 1. Metal conduits and fittings.
  - 2. Metal wire-ways and auxiliary gutters.
  - 3. Boxes, enclosures, and cabinets.
  - 4. Handholes and boxes for underground cabling.
- D. Related Work Specified Elsewhere:
  - 1. Section 01 33 00 Submittal Procedures
  - 2. Section 07 84 00 Fire-stopping
  - 3. Section 26 05 43 Underground Ducts and Raceways for Electrical Systems - for exterior duct banks, manholes, and underground utility construction.
  - 4. Section 26 05 33 Raceways and Boxes for Electrical Systems - for conduits, wire-ways, surface raceways, boxes, enclosures, cabinets, hand holes, and faceplate adapters serving electrical systems.
  - 5. Section 27 05 26 Grounding and Bonding for Communication Systems
  - 6. Section 27 05 43 Underground Conduits and Duct-banks for Systems



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7. Section 27 05 45 Underground Vaults and Spaces for Communications Systems
8. Section 27 05 53 Labeling for Communication Systems
9. Section 27 10 50 Communications Cabling for electrical Power Monitoring Systems
10. Section 27 10 51 Communications Cabling for Building Automation Systems
11. Section 27 11 16 Communication Racks, Cabinets, and Enclosures
12. Section 27 11 19 Copper Patch Panels and Wiring Blocks
13. Section 27 11 20 Optical Fiber Patch Panels and Connectors
14. Section 27 11 23 Communications Cable Management and Ladder Rack
15. Section 27 13 13 Communications Copper Backbone Cabling
16. Section 27 13 23 Communications Optical Fiber Backbone Cabling
17. Section 27 15 13 Communications Copper Horizontal Cabling
18. Section 27 15 43 Communications Faceplates and Connectors
19. Section 27 16 19 Communications Patch Cords, Station Cords, and Cross Connect Wire
20. Section 27 50 15 Distributed Antenna Systems
21. Section 28 05 28 Pathways for Electronic Safety and Security - for conduits, surface pathways, inner-duct, boxes, and faceplate adapters serving electronic safety and security.

### 1.3 REFERENCES

- A. The publications listed in Part 1 of Specification 27 00 10 form a part of this specification to the extent referenced and shall apply to this Section, unless otherwise noted. Where modified, the modification will supersede the original condition.
- B. The publications listed below, including addenda, revisions, updates and errata, form at part of this Specification to the extent they are referenced. Materials are only referenced by their basic designations.
  1. Underwriters Laboratories 6-97 - Rigid Metal Conduit
  2. Underwriters Laboratories 5-96 - Surface Metal Raceway and Fittings
  3. Underwriters Laboratories 514A-96 - Metallic Outlet Boxes
  4. Underwriters Laboratories 6-97 - Rigid Metal Conduit
  5. Underwriters Laboratories 514B-97 - Fittings for Conduit
  6. Underwriters Laboratories 651-95 - Schedule 40 and Schedule 80 Rigid PVC Conduit
  7. Underwriters Laboratories 651A-95 - Type EB and A Rigid PVC Conduit and HDPE Conduit
  8. Underwriters Laboratories 797-93 - Electrical Metallic Tubing
  9. NEMA Standards Publication - VE 1-2002 - Metal Cable Tray Systems
  10. NEMA Standards Publication - VE 2-2006 - Cable Tray Installation Guidelines
  11. American Society for Testing and Materials (ASTM) International:
    - a. ASTM A1011 / A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
    - b. ASTM A123 / A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.



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- c. ASTM A380 - Specification for Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
- d. ASTM A510 - Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
- e. ASTM A513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
- f. ASTM A580 – Standard Specification for Stainless Steel Wire
- g. ASTM A591 - Specifications for Electrodepositing Coatings of Zinc on steel wire or sheets.
- h. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- i. ASTM A641 / A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
- j. ASTM A653 / A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- k. ASTM D769 - Standard Specification for Black Synthetic Iron Oxide

12. ATSM F 2160 - Specification for Solid Wall HDPE Conduit.

#### 1.4 DEFINITIONS

- A. Refer to Section 27 00 00 “Communications” which provides information on Definitions and Abbreviations used in this and related Sections.
- B. Telecommunication Room: (in this Section), means all rooms containing telecommunication cabling, equipment racks and cabinets, cross connect and termination panels and blocks, and/or electronic telecommunication equipment. Included are Telecommunication Entrance Rooms, Equipment Rooms, MDFs, IDF, and Telecommunication Closets/Rooms. Also included are Computer Rooms and dedicated Server Rooms.  
NOTE: This term differs slightly from the term “telecommunication spaces” in that “spaces” also includes work areas, vaults, etc. in addition to the areas mentioned above. It also differs slightly from the term recently adopted to replace the term “telecommunication closets” as it is more expansive. It is used to identify the above areas for the purpose of this section. Where the retired term “Telecommunication Closet” is meant in this Specification, it shall be so used to denote the cross connect area for horizontal cabling.
- C. Wireways or Trunking: shall mean sheet metal troughs with hinged or removable covers for housing and protecting electrical wires and cable and in which conductors are laid in place after the wireway has been installed as a complete system. (NEC 376.2).
- D. Cable Tray: shall mean a unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways. (NEC 392.2). As used within this specification, this term shall mean a metal, ladder-style open ventilated system with side rails and ladder-rung bottom.



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- E. Basket Tray: shall mean a type of cable tray manufactured from welded steel or stainless steel wires into a basket pattern and formed into a trough with two sides and a bottom. Usually zinc or galvanized plated or finished in a powder coat paint. Also known as wire-mesh, basket-style or basket tray. Although this is a cable tray, within this specification the term 'cable tray' shall be defined as indicated above and basket-style tray shall be herein referred to as 'basket tray'.
- F. Telco-Style Cable Runway: shall mean a flat, tubular steel ladder usually used within telecommunication rooms and spaces to support backbone and horizontal cabling. Known also as ladder rack, or telco-style ladder rack, this product shall be herein referred to as 'Telco-Style Cable Runway'.
- G. Fiber Duct: shall mean a raceway channel system manufactured from flame-resistant PVC and ABS materials designed specifically to route fiber optic cables, patch cords and multi-fiber cable assemblies.
- H. Cable Hanger: shall mean a cable support device used to support a limited number of smaller horizontal cables. Often shaped similar to the letter "J" and composed of metal and usually suspended from hangar wires, straps or rods. May also be composed of a fire-retardant fabric material and forming a strap.
- I. Innerduct: shall mean a single or multi-compartment raceway system intended to be installed within a larger duct in order to provide several inner raceways. Often consists of round corrugated or non-corrugated high density polyethylene (HPDE) in sizes ranging from ½" to 2" placed into the larger duct in multiple size configurations. Also available in multi-cell fabric systems with various sized compartments. Primary use to all allow multiple optical fibers to be placed into a larger duct at different times.

## 1.5 ABBREVIATIONS AND ACRONYMS

- A. ARC Aluminum rigid conduit.
- B. GRC Galvanized rigid steel conduit.
- C. IMC Intermediate metal conduit.
- D. RNC Rigid Non-Metallic Conduit (PVC).
- E. PSC PVC Coated Rigid Steel Conduit.
- F. RGC Rigid Galvanized Steel Conduit.

## 1.6 REGULATORY REQUIREMENTS

- A. All Work shall conform to the requirements of NFPA 70.



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- B. All Work shall conform to the requirements of all Federal, State and Local Electrical and Telecommunications Regulations.

1.7 SUBMITTALS

- A. Product submittals and shop drawings shall be in accordance with the requirements of Division 27, Section 27 00 00 – Communications, General and Supplementary Conditions and Division 01 Specification Sections.
- B. Product Data: Manufacturer's Catalog Data shall be submitted for the following items at minimum:
  - 1. Cable hooks and hangars.
  - 2. Metallic and nonmetallic conduit, fittings and hangars.
  - 3. Outlet, pull and junction boxes.
  - 4. Cable tray and related hardware.
  - 5. Basket tray and related hardware
  - 6. Fiber duct and related hardware
  - 7. Wireways and related hardware
  - 8. Innerduct.
  - 9. Fire-rated sleeve assemblies.
  - 10. Support materials and hardware for products specified in this Section.
- C. Data shall include a complete list of parts, special tools, and supplies with source of supply.
- D. Product data to include, but not limited to attachment methods, materials, finishes, approvals, load ratings, and dimensional information.
- E. For all raceways and cable trays:
  - 1. Shop Drawings: Submit shop drawings indicating materials, finish, dimensions accessories, layout, supports, splices, and installation details.
  - 2. Design Calculations: Verify loading capacities for supports.
  - 3. Field verification of dimensions, routing, etc., is directed.
  - 4. Factory-certified test reports of specified products, complying with IEC 61537, NEC, and NEMA VE 1/CSA C22.2 No. 126.1.
- F. Shop Drawings: Provide scaled drawings (not less than 1/8" – 1'-0") indicating routing of conduits and locations of all pull points (to include pull boxes, communications LB, etc.). These locations are to be fully coordinated with all other trades. For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.
- G. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  - 1. Structural members in paths of pathway groups with common supports.



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- 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

H. Qualification Data: For professional engineer.

I. Source quality-control reports.

#### 1.8 DESCRIPTION AND GENERAL SPECIFICATIONS

- A. Provide all labor, supervision, materials, tools, equipment and services required to complete the work described herein and shown on the drawings and as required to provide a fully operational system.
- B. Raceways, cable tray, hangars and other materials and appurtenances shall be UL listed, approved and suitable for the environment where installed.
- C. The drawings, which constitute a part of these specifications, indicate the general route of the pathway systems. Contractor shall verify existing field conditions and coordinate exact routing, location, distance and levels and other work of this Section with other trades prior to installation.
- D. Notify the Designer or Owner's Representative of any changes due to conflicts with other trades work, or due to any other reason other than of a minor nature prior to proceeding with work.
- E. Make necessary provisions for storage of materials and equipment at the site to ensure the quality and condition of the product to be installed. Use only materials and products that are new, free of defect, and which arrive unopened and in the original container at the jobsite.
- F. Notify the Owner's Representative at least two (2) full working days prior to covering of concealed communications work.

#### 1.9 QUALITY ASSURANCE

- A. Conform to all conditions within "Quality Assurance and Workmanship" paragraph of. Section 27 00 10 General Provisions of Communications Systems.

#### 1.10 CONTRACTOR QUALIFICATIONS

- A. Conform to all conditions within "Quality Assurance and Workmanship" paragraph of. Section 27 00 10 General Provisions of Communications Systems
- B. All workers installing conduits, raceways, cable trays, basket trays, fiber duct, wireways and other pathways shall be fully trained and certified in the installation by the manufacturer of each of the systems prior to start of work including as follows:



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1. Cable Tray – Cablofil/PW, a division of Legrand
  2. Basket tray – Flextray, a division of Cooper B-Line
  3. Fiber duct – FiberRunner by Panduit
  4. Telco-style cable runner – Chatsworth CPI
- C. Contractor to submit proof of training and certification for each technician working on the system prior to start of work.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Provide necessary tools and materials not specified in the parts list, (screws, bolts, washers, unistrut supports, etc.).

### 2.2 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

- A. Refer to Section 26 05 33 “Raceway and Boxes for Electrical Systems” - Part 2 for products identified in Part 1 of this Section.

1. Comply with TIA-569-D.

### 2.3 PATHWAYS

- A. General Requirements: Comply with TIA-569-D.

- B. Design Intent: for this project the following guidelines should be followed

1. High level containment: should be in the form of J hooks and conduit, with fire stopped sleeves used to penetrate walls where needed.
2. Low level containment: where shown on plans low level basket tray should be utilized for all low level outlets, rectangular slots should be used to pass through fire barriers with fire-stopping re-instated once cable installation is complete (i.e. full installed and tested)

- C. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
2. Support brackets with cable tie slots for fastening cable ties to brackets.
3. Lacing bars, spools, J-hooks, and D-rings.
4. Straps and other devices.



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- D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
- E. Outlet boxes shall be Single/Double gang standard electrical back box provided by others.

## 2.4 PATHWAY CABLE SUPPORTS

### A. J-Type Cable Support Hooks

- 1. Type: Cable support hooks shall be a wide-base type for use in a Non-continuous cable support with bearing surface of sufficient width to comply with required bend radii of high-performance cables
- 2. Hooks shall be Electro-galvanized or G60 finish for smooth cable pull and corrosion resistance with rating for indoor use in non-corrosive environments
- 3. Hooks shall:
  - a. Comply with UL, cUL, NEC and EIA/TIA requirements for Category 6 structured cabling systems.
  - b. Provide a bearing surface of sufficient width to limit cable bending per cable manufacturers' recommendations. Provide optimal support for high-performance
  - c. Data cable, including Category 6, and fiber optics cables.
  - d. Have flared edges to prevent damage while installing cables.
  - e. Retainer straps: Non-continuous cable supports sized 1-5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces
  - f. Be capable of being installed in a single- or multiple-hook ("tree") configuration.
- 4. The use of "strap" or "flexible" type cable supports shall not be permitted.
- 5. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Panduit Part numbers:
    - 1) J Hook Screw on Beam 2inch JP2SBC50R-L20
    - 2) J Hook Hammer on Beam 2 inch JP2HBC25R-L20
    - 3) J Hook Z Purlin Clip – Angle 2 inch JP2ZP-L20
    - 4) J Hook Z Purlin Clip – Vertical 2 Inch JP131CP-L20
  - b. Caddy Part Numbers:
    - 1) CADDY CAT12 (for 1-16 Category-rated 4-pair cables) or approved equal.
    - 2) CADDY CAT21 (for 16-50 Category-rated 4-pair cables) or approved equal.
    - 3) CADDY CAT32 (for 51-80 Category-rated 4-pair cables) or approved equal.

### B. Adjustable Strap Supports



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1. Type: Adjustable non-continuous cable support sling
2. Construction: Steel and woven laminate, with length adjustment to hold up to 425 4-pair UTP
3. Use Rating: Indoors use in non-corrosive environments. Rated to support Category 5 and higher cable, or optical fiber cable
4. Load Limit: Static load limit of 100 lbs.
5. Plenum Rating: Suitable for use in air handling spaces
6. Approved Manufacturer:
  - a. CADDY CAT425 (for 1-425 Category-rated 4-pair cables) or approved equal.

## 2.5 CONDUITS

### A. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-C.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. ARC: Comply with ANSI C80.5 and UL 6A.
5. IMC: Comply with ANSI C80.6 and UL 1242.
6. PVC-Coated Steel Conduit:
  - a. Comply with NEMA RN 1.
  - b. Coating Thickness: 0.040 inch, minimum.
7. EMT: Comply with ANSI C80.3 and UL 797.
8. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - a. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
  - b. Fittings for EMT:
    - 1) Material: Steel.
    - 2) Type: Setscrew or compression.
  - c. Expansion Fittings: PVS or steel to match conduit type, complying with UL 467, rated for environmental conditions where installed, and including flexible external bonding jumper.
  - d. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
9. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

### B. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-C.



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3. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
4. Rigid HDPE: Comply with UL 651A.
5. Continuous HDPE: Comply with UL 651B.
6. Fittings for RNC: comply with NEMA TC 3; match to conduit or tubing type and material.
7. Solvent Cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Rigid Conduit

1. Rigid Galvanized Steel Conduit (RGC)
  - a. Construction: Rigid steel conduit hot-dipped galvanized inside and out with threaded ends meeting ANSI C80.1.
  - b. Couplings: Unsplit, NPT threaded with galvanizing equal to (and compatible with) conduit. Running thread or set screw threaded fittings (except for three piece and watertight split couplings) are not acceptable.
  - c. Nipples: Same as conduit, factory-made up to 8 inches in diameter, no running threads. Hot-dipped galvanized.
  - d. Threaded hubs or double locknuts.
  - e. Insulating or grounding-type bushings

D. Electrical Metallic Tubing (EMT)

1. Interlocking, single strip hot dipped galvanized, or sherardized steel.
2. Connectors and couplings:
  - a. 2 inch (50mm) and smaller trade size: Use only concrete and rain tight connectors. Connectors shall have insulated throats and utilize solid compression ring. Set-screw and indenter type fittings are not permitted.
  - b. Over 2 inch (50mm) trade size: Use four-screw set screw type only. Set screws shall be case hardened and have hex head with pointed up to provide positive grounding.
  - c. Approved Manufacturers:
    - 1) Allied Tube and Conduit
    - 2) Western Tube and Conduit
    - 3) Or other approved equal

E. Rigid Non-Metallic Conduit (RNC)

1. Type: U.L. 651 listed, NEMA TC-2, Schedule 40 rigid polyvinyl chloride (PVC) approved for burial in concrete encasement.
2. Size: 4", or as specified on Plans.
3. Construction: Shall meet NEMA TC-2 and U.L. 651 Schedule 40 standards.
4. Fittings: NEMA TC3 and U.L. 514b matched to conduit and material. Includes conduit fittings, conduit couplings, junction box adapters, female adapters, male terminal adapters, reducers, caps, end bells, and conduit sweeps. Utilize appropriate cement as recommended by conduit and fitting manufacturer.



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5. Factory manufactured conduit sweeps shall be of a single arc with a radius of not less than 10 times the internal diameter of the conduit.
6. Conduit, fittings and cement shall be produced by the same manufacturer to assure system integrity.
7. Approved Manufacturer:
  - a. Carlon (Thomas & Betts) or approved equal.

F. Surface Raceway

1. Factory-painted steel, aluminum or PVC or as specified or as indicated on Drawings.
2. Provide barrier where required for wiring system separation.

G. Expansion and deflection couplings:

1. Provide in accordance with Underwriters Laboratories (UL) 467 and 514B.
2. Accommodate at a minimum 0.75" deflection, expansion and contraction in any direction.
3. Accommodate at a minimum 30 degrees of angular deflection in any direction.
4. Provide with an internal flexible braid sized to guarantee conduit ground in accordance with UL 467.

H. Conduit Supports:

1. Conduit support parts and hardware shall be zinc-coated, or provide equivalent corrosion protection.
2. Trapeze hangers for multiple conduits: Not less than 1-5/8" x 1-5/8" 12-gauge cold formed, round lipped channels, with no less than 3/8 hangar rods. Rods shall be secured with machine nuts, above and below channel with locknut on one side. Straps shall be two-piece construction and be by same manufacture as channel.
3. Individual conduit hangar: Shall be designed for the purpose, and be provided with a closure bolt and nut, and provision for fastening to hangar rod.
4. Approved Manufacturers:
  - a. Unistrut, a Tyco Company
  - b. Caddy
  - c. Thomas & Betts
  - d. Allied Tube and Conduit
  - e. Cooper B-Line
  - f. Other approved equal.

I. Conduit cable protection

1. Each conduit terminating within a telecommunication space will be fitted with a conduit waterfall.
2. Product number: Panduit CWF400.



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2.6 OUTLET, JUNCTION, AND PULL BOXES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Hoffman; a Pentair company.
  - 2. Hubbell Incorporated; Killark Division.
  - 3. RACO; a Hubbell company.
  - 4. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets.
  - 1. Comply with TIA-569-C.
  - 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Box extensions used to accommodate new building finishes shall be of the same material as recessed box.
- E. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Device Box Dimensions: Refer to Section 27 05 53 "Conduits and Backboxes."
- H. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 12 for indoor use only, Type 3R or Type 4x for outdoor use only, with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Nonmetallic Enclosures: Material: Plastic
  - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- J. Interior Cabling:
  - 1. General: Outlet and pull boxes shall be pressed steel, zinc coated with plaster ring where applicable. Large pull boxes shall be fabricated sheet steel, zinc coated or baked enamel finish, with return flange and screw retained cover. Minimum sizes shall be as specified in NEC Article 300.
  - 2. Surface Metal Raceway: Boxes of same manufacturer and to match raceway. Boxes to accommodate standard devices and device plates. Boxes shall be of sufficient depth and size to accommodate recommended cable manufacturer(s)



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bend radii and storage requirements or as specified elsewhere in the Specification or as indicated on drawings.

3. Concrete and Masonry: Boxes for casting in concrete or mounting in masonry walls shall be of the type specifically designed and manufactured for that purpose.
4. Outlet: Provide, as required for work shown and the installation, minimum 4" junction box, 2-1/8" deep, with plaster or mud ring to finished wall, and with finished cover plates as specified.
5. Approved Manufacturer for dry locations: Raco, Steel City, Appleton or approved equal.

K. Exterior Cabling:

1. Outlet and exterior junction or pull boxes shall be cast or malleable iron or shall be cast of corrosion resistant alloy compatible with raceway to which it is connected. Pull boxes shall be of heavy gauge steel and hot dipped galvanized. All boxes shall be provided with gasketed covers.
2. Plastic and PVC boxes may be permitted where not subject to damage and with prior approval of Designer prior to bid, or unless otherwise noted.
3. Exterior boxes are those boxes in direct contact with the weather. Boxes installed in protected areas and not directly exposed to rain, water or other wet weather conditions may be as indicated for Interior Cabling.
4. Approved Manufacturer for damp or wet locations: Crouse-Hinds FS or FD or approved equal.

## 2.7 FLOOR BOXES

A. Installed in concrete:

1. Single device floor boxes shall be Steel City, fully adjustable with polished brass cover and individual flaps for duplex cover operation.
2. Multi-gang boxes shall be Steel City or Hubbell with covers.

B. Installed in wood or raised access floors:

1. Multi-gang boxes shall be Steel City or Hubbell with covers.

C. Multi gang boxes: Provide cover plates for devices and blank plates for unused openings. Plates shall be fabricated by box manufacturer and suitable for the devices installed.

D. Boxes installed in carpet areas shall be equipped with carpet flanges.

E. Boxes shall be provided with compartments able to store cabling and maintain proper bend radii for all cabling.



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2.8 SURFACE METAL RACEWAY

- A. Raceway shall be compact modular design constructed of high-impact polypropylene or of .60" thick extruded #6063-T5 aluminum with satin anodized finish.
- B. Raceway shall be Wiremold or as shown on Plans. Furnish complete with appurtenances as required.
- C. Provide standard accessories such as splice plates, bends, covers, adapter plates, end caps, etc. associated with surface metal raceway system from the same manufacturer supplying surface raceway, and as listed in manufacturer catalog as compatible with surface raceway, in order to provide a complete and matching system.
- D. All surface raceways shall maintain proper termination and bend radii for all installed cables

2.9 CABLE TRAY

A. General

- 1. Cable tray sections shall be made of straight sections, horizontal and vertical bends, tees, drop outs, supports and accessories as defined in the latest standards publication VE-1. Standard cable trays shall be UL classified as equipment grounding conductors (excluding stainless steel).
- 2. Cable tray shall meet NEMA Class with a safety factor of 1.5.
- 3. Provide aluminum cable tray of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units; in compliance with applicable standards; and with other additional construction features as specified herein.

B. Materials and Finishes

- 1. Materials:
  - a. Aluminum: Straight sections, tees, radius corners, crosses and fittings shall be constructed with tray side rails, rungs, and channels of extruded, copper-free aluminum alloy 6063-T6
  - b. Splice plates: Splice plates shall be furnished with straight sections and fittings, and shall be included in unit prices.
  - c. Covers and Accessories: Provide items in accordance with standards shown in catalog accessories section.

C. Size:

- 1. Depth: Cable tray depth will be 4 inches (105mm), unless otherwise shown on drawings.
- 2. Width: Cable tray width will be 12 inches (300mm) and 24 inches (600mm) or as indicated on drawings.



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3. Length: Cable tray section length will be 10 or 12 feet, unless otherwise shown on drawings.
4. Flange type:
5. Flange-type shall be flange-in.
6. Rung Spacing: 9"
7. Rungs shall be aluminum boxed-type and spaced at standard 9 inch intervals.

D. Catalog accessories:

1. Provide standard accessories such as splice plates, hangars, supports, bends, covers, etc. associated with cable tray system from the same manufacturer supplying cable tray, and as listed in manufacturer catalog as compatible with selected cable tray, in order to provide a complete and matching system.
2. Wall supports:
3. Where indicated, provide single or double unistrut-style wall supports such as Cablofil/PW 0215 or 216 series or approved equal.
4. Approved Manufacturers:
  - a. Cablofil/ PW, a Legrand company – System 4D08 for 12" and 24" wide tray series
5. Approved Products:
  - a. Straight section - 12": Part #09-4D08-0012-12
  - b. Straight section - 24": Part #09-4D08-0012-24
  - c. 90- degree horizontal elbow - 12": Part #LD-4A1I-9012-12
  - d. 90-degree horizontal elbow - 24": Part #LD-4A1I-9012-24
  - e. Standard horizontal tee - 12": Part #LD-4A1I-2012-12
  - f. Standard horizontal tee - 24": Part #LD-4A1I-2012-24
  - g. Standard horizontal cross - 12": Part #LD-4A1I-1012-12
  - h. Standard horizontal "cross", 24": Part #LD-4a1I-1012-24
  - i. Hanger channel, 12": Part #G-0393-16-S6
  - j. Single strut wall bracket, 12": Part #G-0215-16

2.10 BASKET TRAY

A. General

1. Cable tray sections shall be made of straight sections, horizontal and vertical bends, tees, drop outs, supports and accessories as defined in the latest standards publication VE-1.
2. Cable tray shall meet NEMA Class with a safety factor of 1.5.
3. Provide wire-basket style cable tray of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with other additional construction features as specified herein.
4. All straight section longitudinal wires shall be constructed with a continuous top wire safety edge. Safety edge must be kinked and T-welded on all tray sizes.



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5. Wire basket cable tray shall be made of high strength steel wires and formed into a standard 2 inch by 4-inch wire mesh pattern with intersecting wires welded together. All mesh sections must have at least one bottom longitudinal wire along entire length of straight section.

B. Materials and Finishes

1. Materials:
  - a. Product shall be wire welded, bent and surface treated after manufacture.
  - b. Splice plates: Splice plates shall be furnished with straight sections and fittings, and shall be included in unit prices.
  - c. Covers and Accessories: Provide items in accordance with standards shown in catalog accessories section.

C. Finishes:

1. Black Powder Coat: Straight sections shall be powder coated black with an average paint thickness of 1.2mils (30microns) to 3.0mils (75microns). Pre-Galvanized Zinc: Wall brackets and other pre-galvanized accessories shall be coated with zinc in accordance with ASTM A653.

D. Size:

1. Depth: Basket tray depth will be 4 inches (105mm) or 6 inches (150mm) as indicated on drawings.
2. Width: Basket tray width will be as indicated on drawings.
3. Length: Basket tray section length will be 10 or 12 feet, unless otherwise shown on drawings.

E. Catalog accessories:

1. Provide standard accessories such as splice plates, hangars, supports, bends, covers, etc. associated with cable tray system from the same manufacturer supplying cable tray, and as listed in manufacturer catalog as compatible with selected cable tray, in order to provide a complete and matching system.

F. Tray Splices:

1. Provide quantity of splice connectors per manufacturers recommendations.

G. Accepted Products:

1. Straight Sections:
  - a. 4" x 12": Flextray FT4X12X10 or approved equal
  - b. 4" x 16": Flextray FT4X16X10 or approved equal
  - c. 4" x 18": Flextray FT4X18X10 or approved equal
  - d. 4" x 24": Flextray FT4X12X10 or approved equal
  - e. 6" x 18": Flextray FT6X18X10 or approved equal
  - f. 6" x 24": Flextray FT6X12X10 or approved equal



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2. Hold-down plate:
  - a. Flextray FTA6HDZN or approved equal
  - b. Flextray SUPT WASHERZN or approved equal
3. Connector Splice:
  - a. Flextray WASHER SPL KITBLE or approved equal
4. Drop-out fitting:
  - a. Flextray DROP OUTBLE or approved equal
5. Radius Shield:
  - a. 4" deep tray: Flextray FTA4RS or approved equal
  - b. 6" deep tray: Flextray FTA6RS or approved equal
6. Rubber end cap:
  - a. Flextray B719BE or approved equal
7. Ground wire attachment fitting:
  - a. Flextray GROUNDBOLT or approved equal
8. Triangle Wall Support Bracket:
  - a. 12": Flextray FTB12CSGLV or approved equal
9. Flextray Divider
  - a. Allows separation within a single tray
  - b. Provide 4" divider for 4" deep tray and 6" divider for 6" deep tray
  - c. 4" divider: Flextray 4 IN DIVIDER\_
  - d. 6" divider: Flextray 6 IN DIVIDER\_
10. Straight Sections:
  - a. Cabofil
    - 1) 4" x 4": Flextray FT4X4X10
    - 2) 4" x 6": Flextray FT4X6X10
  - b. Chatsworth OnTrac basket tray
    - 1) 4" x 4": Part Number: 34821-604
    - 2) 4" x 6": Part Number: 34821-606
  - c. or approved equal
11. Connector Splice:
  - a. Cabofil
    - 1) Flextray WASHER SPL KITBLE
  - b. Chatsworth OnTrac basket tray
    - 1) Standard kit Part Number: 34738-X01
    - 2) Splice washer & bolt: Part Number: 34728-X01
  - c. or approved equal
12. Drop-out fitting:
  - a. Cabofil
    - 1) Flextray DROP OUTBLE



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- b. Chatsworth
    - 1) Radius drop: Part Number: 34741-X01
  - c. or approved equal
13. Ground wire attachment fitting:
- a. Cabofil
    - 1) Flextray GROUNDBOLT
  - b. Chatsworth
    - 1) Split bolt grounding clamp: Part Number: 34838-001
  - c. or approved equal
14. Wall Support Bracket:
- a. Cabofil
    - 1) 12": Flextray FTB06CSGLV
  - b. Chatsworth OnTrac basket tray
    - 1) 4": Part Number: 34733-X04
  - c. or approved equal
15. Flextray Divider
- a. Allows separation within a single tray
  - b. Provide 4" divider for 4" deep tray
  - c. Cabofil
    - 1) 4" divider: Flextray 4 IN DIVIDER
  - d. Chatsworth OnTrac Divider
    - 1) 4": Part Number: 34743-504
  - e. or approved equal
  - f.

2.11 SLEEVES

A. Conduit Sleeves

- 1. Material: UL Listed EMT electrical conduit OR UL listed approved fire-rated firewall assembly for use with telecommunication cabling as indicated on plans.
- 2. Size: Standard trade sizes over 1" allowed for fire-rated or non-fire-rated partitions at locations other than those for main pathways (where connecting cable or basket tray together on each side of wall).
- 3. All conduits sleeves shall be reamed and provided with approved bushings at each end.

B. Sleeves for Telecommunication Rooms

- 1. Device: UL listed approved fire-rated firewall assembly for use with telecommunication cabling at locations where connecting cable or basket trays together on each side of a fire-rate partition.
- 2. Construction: Metal sleeve containing an intumescent insert material that adjusts automatically to cable additions or subtractions.
- 3. F-rating: Equal to fire rating of barrier being passed through.



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4. Air Containment: Provide product containing ability to mitigate loss of cold and/or hot air between conditioned spaces (e.g. - Hilti CP653).
5. Accepted Manufacturers:
  - a. EZ Path Fire Rated Pathway.
  - b. Hilti CP653

## 2.12 FIBER DUCT

### A. General

1. Fiber duct sections shall be made of straight sections, horizontal and vertical bends, tees, crosses drop outs, spill outs, tubing and supports and accessories as defined in the latest standards publication VE-1. Standard cable trays shall be UL classified as equipment grounding conductors (excluding stainless steel).
2. Cable tray shall meet NEMA Class with a safety factor of 1.5.
3. Provide wire-basket style cable tray of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with other additional construction features as specified herein.
4. All straight section longitudinal wires shall be constructed with a continuous top wire safety edge. Safety edge must be kinked and T-welded on all tray sizes.
5. Wire basket cable tray shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All mesh sections must have at least one bottom longitudinal wire along entire length of straight section.

### B. Accepted Products:

1. Straight Sections:
  - a. 12"x4": Panduit FiberRunner FR12X4YL6 or approved equal
  - b. 6"x4": Panduit FiberRunner FR6X4YL6 or approved equal
  - c. 4"x4": Panduit FiberRunner FR4X4YL6 or approved equal
2. Straight Section Split-Hinged Covers:
  - a. 12": Panduit FiberRunner FRHC12YL6 or approved equal
  - b. 6": Panduit FiberRunner FRSHC6YL6 or approved equal
3. Straight Section Snap-on Covers:
  - a. 4": Panduit FiberRunner FRHC4YL6 or approved equal
4. Couplers:
  - a. 12"x4": Panduit FiberRunner FRBC12X4YL or approved equal
  - b. 6"x4": Panduit FiberRunner FRBC6X4YL or approved equal
  - c. 4"x4": Panduit FiberRunner FRBC4X4YL or approved equal
5. Horizontal Right Angle Corners:
  - a. 12"x4": Panduit FiberRunner FRRA12X4YL or approved equal



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- b. 6"x4": Panduit FiberRunner FRRA6X4YL or approved equal
- 6. Right Angle Corner Split-Hinged Covers:
  - a. 12": Panduit FiberRunner FRRASC12YL or approved equal
  - b. 6": Panduit FiberRunner FRRASC6YL or approved equal
- 7. Horizontal Standard Tees:
  - a. 12"x4": Panduit FiberRunner FRT12X4YL or approved equal
  - b. 6"x4": Panduit FiberRunner FRT6X4YL or approved equal
- 8. Split Covers for Standard Horizontal Tees:
  - a. 12"x4": Panduit FiberRunner FRTS126YL or approved equal
  - b. 6"x4": Panduit FiberRunner FRTSC6YL or approved equal
- 9. Horizontal Reducing Tees:
  - a. 12"x4" with 6"x4" exit: Panduit FiberRunner FRT12X4W6YL or approved equal
- 10. Split Covers for Reducing Tees:
  - a. 12"x4" with 6"x4" exit: Panduit FiberRunner FRTCS12W6YL or approved equal
- 11. Horizontal Cross Fittings:
  - a. 12"x4" 4-way cross: Panduit FiberRunner FRFWC12X4YL or approved equal
  - b. 6"x4" 4-way cross: Panduit FiberRunner FRFWC6X4YL or approved equal
- 12. Split Covers for Horizontal Cross Fittings:
  - a. 12"x4" 4-way cross: Panduit FiberRunner FRFWCSC12X4YL or approved equal
  - b. 6"x4" 4-way cross: Panduit FiberRunner FRFWCSC6YL or approved equal
- 13. Vertical Tee Fittings:
  - a. 12"x4" Vertical Tee: Panduit FiberRunner FRVT12X4YL or approved equal
  - b. NOTE: This fitting is used at the Computer Room IDF Vertical Managers
- 14. Spill-over Fittings:
  - a. 2"x2" exit Spillover Fitting: Panduit FiberRunner FRSPJ2X2YL or approved equal
  - b. 4"x4" exit Spillover Fitting: Panduit FiberRunner FRSPJ4X4YL or approved equal
- 15. Covers for Spill-over Fittings:
  - a. Cover for FRSPJ2X2YL with 12"x4" duct: Panduit FiberRunner FRSPJC212YL or approved equal
  - b. Cover for FRSPJ2X2YL with 6"x4" duct: Panduit FiberRunner FRSPJC26YL or approved equal
  - c. Cover for FRSPJ4X4YL with 12"x4" duct: Panduit FiberRunner FRSPJC412YL or approved equal



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- d. Cover for FRSPJ4X4YL with 6"x4" duct: Panduit FiberRunner FRSPJC46YL or approved equal
- 16. Upspout Fittings:
  - a. 16"x4" Upspout: Panduit FiberRunner FRUPS6X4YL or approved equal
- 17. Spillout Fittings to convert to corrugated tubing:
  - a. 2"x2" 1-port Spillout to 1.5" tubing: Panduit FiberRunner FIDT2X2YL or approved equal
  - b. 4"x4" 2-port Spillout to 1.5" tubing: Panduit FiberRunner FIDT4X4YL or approved equal
- 18. 1-1/2" Corrugated Loom Split Tubing:
  - a. Panduit FiberRunner CLT150F-X4 or approved equal
- 19. Fiber Duct Mounting Hardware:
  - a. 12" Center Support Bracket: Panduit FiberRunner FR12CS12 or approved equal
  - b. 6" Center Support Bracket: Panduit FiberRunner FR6CS12 or approved equal
  - c. 12" Threaded Bracket for all thread: Panduit FiberRunner FR12TRBN58 or approved equal
  - d. 6" Threaded Bracket for all thread: Panduit FiberRunner FR6TRBN58 or approved equal

## 2.13 BOXES AND ENCLOSURES

- A. General Requirements for Boxes and Enclosures:
  - 1. Comply with TIA-569-D.
  - 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- E. Metal Floor Boxes:
  - 1. Material: sheet metal.
  - 2. Type: Fully adjustable.
  - 3. Shape: Rectangular.



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- 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- H. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- I. Gangable boxes are prohibited.

2.14 CONDUIT INNER DUCT

- A. General Requirements for Inner duct:
  - 1. Comply with TIA-569-D.
  - 2. Inner Duct to be installed in all conduits designated for telecom use
  - 3. Material: White Polyester and Nylon resin polymer
- B. Standard Outdoor Textile Inner duct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile inner duct containing 1250lb polyester flat woven pull tape.
- C. Textile inner duct fixings
  - 1. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile inner ducts within a 4-inch inside diameter conduit, e.g.: a. 4-inch plug with nine holes for cables in a 3 pack (9-cell) configuration
  - 2. Termination Bags: Inflation-type bags for sealing and securing around one or more textile inner ducts and cables within 2-inch outside diameter or larger conduit.
    - a. Furnish all 4" conduits with three (3) x 3" tall 3-cell inner duct,
      - 1) Manufacturer: Maxcell
      - 2) product number: MXC 3456 BK XXX
- D. Interior use in overhead application
  - 1. Type: Carlon Plenum-Gard series with tape.
  - 2. Fire rating: Plenum-rated
  - 3. Color: Orange.
  - 4. Size: 1' or 1-1/4" as indicated.
  - 5. Approved Manufacturer: Carlon
- E. Interior – Split Innerduct



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1. Type: Carlon Plenum -Gard
2. Option: Split duct
3. Fire rating: Plenum-rated
4. Color: Orange.
5. Approved Manufacturer: Carlon

F. Exterior

1. Refer to Section 27 05 43 Underground Conduits and Ductbanks for Communications Systems for underground applications.
2. For aboveground exterior applications:
  - a. Type: Carlon Riser-Gard series with tape. Split duct NOT allowed.
  - b. Fire rating: Riser-rated or PVC as indicated.
  - c. Color: White.
  - d. Size: 1' or 1-1/4" as indicated.
  - e. Approved Manufacturer: Carlon or approved equal.

2.15 SEISMIC BRACING

- A. Provide seismic bracing in line with recommendations by manufacturer. Seismic bracing fittings and accessories shall be provided to meet the requirements set by the structural calculations. Contractor to provide calculations and seismic bracing details as required for the installation at the site.

2.16 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional TDS installation shall be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install all pathways and raceway systems as shown on the drawings and as required in other sections of the Contract Documents.
- B. Install pathways and raceways in accordance with UL, NEC, and manufacturer's recommendations, as shown and as hereinafter specified.
- C. Raceway and pathway routing is conceptual, unless specifically shown otherwise. Install pathways and raceways as to comply with field conditions. Where shown on drawings, install as shown. Deviations are approved only to avoid interferences and only after drawings showing such proposed deviations have been submitted to and approved by the Owner's Representative.



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- D. Coordinate installation with other trades. Provide conduit, cable tray and raceways bending, fittings, supports, junction boxes, supports and all incidentals necessary for a complete installation.
- E. Install pathways and raceways parallel or at right angles to building members.
- F. Cut all raceways square with a hacksaw or bandsaw, remove burrs and draw up tight.
- G. Assure pathway and raceway installation does not encroach into ceiling height headroom, doorways or walkways.
- H. Where drilling is required for vertical pathways or conduits, locate holes so as not affect structural section such as ribs or beams.
- I. Do not attach supports to gypsum wallboard.
- J. Do not hang or suspend raceways, cable tray or boxes from any earthquake bracing.
- K. Contractor shall coordinate and verify with Structural Engineer and General Contractor all telecommunication pathways and cabling suspended from the structure above or the floor below have been coordinated and engineered and that all such weights, loads and/ or seismic requirements of these pathways, cabling and supports will be able to safely and properly supported.

### 3.2 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
  - 1. Exposed Conduit: GRC, RMC, Type EPC-40-PVC.
  - 2. Concealed Conduit, Aboveground: EMT, GRC, RNC, Type EPC-40-PVC.
  - 3. Underground Conduit: RNC, Type EPC-40-PVC, smooth-wall HDPE, concrete encased.
  - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage: EMT.
  - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
  - 3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
    - d. Gymnasiums
  - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT or inner duct.
  - 5. Damp or Wet Locations: GRC.



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6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, communications-cable pathway or EMT for non-plenum rated cabling.
  7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
  8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: Plenum-type, communications-cable pathway.
  9. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 1-1/4 inch (35-mm) trade size. Minimum size for optical-fiber cables is 2 inches (53 mm).
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).
- H. All pathways shall be sized to allow for a minimum of 25% growth.

### 3.3 PATHWAY CABLE SUPPORTS

- A. In any areas where cable tray is not provided, provide J-hooks or other specified hangars to support horizontal cabling runs. Use D-rings on vertical surfaces as specified in Section 27 11 23 Communications Cable Management and Ladder Rack. Cable supports shall be permanently anchored to the building structure or substrates. Provide attachment hardware and anchors designed for the structure to which attached, and that are suitably sized to carry the weight of the cables to be supported.
- B. Maximum spacing for supports for open cable runs shall be 42". Spacing distance shall be reduced as necessary to achieve anchoring of supports to building structure or substrates. Cable bundles shall not sag more than 4" between supports. Provide additional supports where required to prevent cable bundles from sagging more than 4".



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- C. Install cable supports in accordance with all cable installation, handling, pulling and support requirements for the intended cable. Refer to the applicable Specification Section within Division 27 and for the cable support manufacturer's recommendations for these requirements. Where a requirement supersedes the maximum cable span or sag requirements above; specifically but not limited to those concerning bend radius requirements, pulling and storage methods, bundle size requirements, and effects on cable from compression from the weight of superior cabling; then the more stringent requirement shall apply.

### 3.4 CONDUITS

#### A. General

1. Minimum conduit size shall be 3/4" trade size, but not less than the size indicated on the drawings
2. For wall phone outlets, provide 3/4" conduit from outlet box to accessible space.
3. For wall data and voice outlets, provide 1" conduit from outlet box to accessible space.
4. For wall outlets, conduits shall be stubbed into accessible ceiling space.
5. Support raceways by straps, suitable clamps or hangers to provide a rigid installation
6. Perforated strap hangers or twisted wire attachments are not permitted.
7. Do not support or fasten raceways to other pipe or in a manner to prevent the ready removal of either pipe.
8. All conduit ends shall be provided with insulated bushings.
9. Carefully form bends to avoid flattening raceway. Use factory bends or field bend with standard conduit bending equipment. Bending with a pipe vise or any device other than standard equipment is prohibited. Flattened, deformed or dented conduit is not permitted. Remove and replace damaged conduit with new undamaged material.
10. Provide minimum 90 lb. pull string or wire in all empty conduits; sleeves are exempted from this provision.
11. Fill capacity for any conduit shall not exceed 40% of the cross-sectional area of the conduit for any and all conductors in accordance with the National Electrical Code.
12. Conduit bends and lengths shall be considered for the application and shall meet the minimum bend radius and pulling tension requirements for installation of Category 6 or greater copper cable, optical fiber cable and multipair copper cable. Coordinate with Engineer of Record and document all calculations.
13. Flexible conduit to not be used in lieu of conduit bends and offsets
14. Aboveground conduits in buildings shall not exceed 100 feet between pull boxes unless approved by Microsoft for communications works.
15. Conduits shall contain no more than three quarter bends (270 cumulative degrees) between pull boxes or backboards. The minimum bend radius of any conduit bend shall be as follows:



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MINIMUM ALLOWABLE CONDUIT MINIMUM RADIUS	
Conduit Trade Size	Radius in Inches (mm)
3/4"	6" (150)
1"	9" (230)
1-1/4"	14" (350)
1-1/2"	17" (430)
2"	21" (525)
2-1/2"	25" (635)
3"	31" (775)
3-1/2"	36" (900)
4"	45" (1125)

B. Rigid Non-Metallic Conduit (RNC)

1. Use of RNC permitted for underground installation for telecommunication raceways and in contact with earth only if allowed by local codes or as indicated on Plans.
2. Use wide radius sweep bends only with minimum bend radius 10 times outside conduit diameter or as indicated on Plans.
3. Provide minimum trade size 4" for underground installations unless indicated otherwise herein or on Plans, or with written approval of the Designer or Owner's Representative.

3.5 EXPANSION JOINTS

- A. Conduits that are secured to the building structure on opposite sides of a building expansion joint shall utilize expansion and deflection couplings. Use of flexible metallic conduit in lieu of specified expansion couplings are not allowed unless indicated otherwise or approved prior to bid by the Designer.

3.6 OUTLET, JUNCTION, AND PULL BOXES

A. Anchoring:

1. All boxes shall be firmly anchored; either directly or with concealed bracing to building studs or structural member. Boxes must so anchored so they do not shift or move when devices are operated.

B. Flush Mounting:



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1. All boxes intended for flush mounting shall have the front edge of the box; plaster ring or extension ring even with the final finished surface of the wall or ceiling. Where cabinetry or other furniture is to be placed permanently against finished wall, the box, plaster or extension ring shall have the front edge even with the final surface against which the cover plate is to rest.
2. Flush-mounted or recessed boxes on opposite sides of a common wall shall not be mounted back-to-back. Provide a minimum of 6" horizontal separation between the closest edges of the boxes. Where flush-mounted or recessed within fire-rated walls, this distance shall be not less than 24".

C. Device Outlets:

1. Check and verify outlet locations that are indicated on Architectural drawings, door swings, installation details, shop drawings, and layout of suspended ceilings and locations of plumbing, heating, ventilating and other equipment requiring work provided by this Division. Study equipment drawings to assure proper coordination and connection per codes and/or standards.
2. Each data outlet in a wall or floor to be served by (1) 1 inch conduit and a 4s x 2 1/8 deep device box with a single-gang mud ring.
3. Wall mounted telephones shall be served by (1) 3/4 inch conduit and a 4s x 2 1/8 deep device box with a single-gang mud ring. The outlet box shall have a clearance of 12 inches of wall surface on sides.
4. Where more than one outlet is shown or specified at specified to be at the same elevation, or where one is above another, align them exactly on centerlines horizontally or vertically. Relocate as directed any outlets which are not so installed without any additional cost to Owner.
5. Install typical device outlets in walls at same height/elevation as electrical outlets unless noted or indicated otherwise on the drawings or within these Specifications.
6. For locations in acoustical ceilings, locate device outlets either at the corner joint or in the center of the tile, whichever is closer to the normal spacing. Locate all outlets in the same room in the same panel position, unless otherwise noted.
7. Where outlets are installed in or near cabinetry, such as between a door and cabinet or between two cabinets, install exactly as shown. Relocate as directed any outlets which are not so installed without any additional cost to Owner.

D. Blank Covers:

1. Provide blank covers over all junction and pull boxes; and unused outlet boxes.

E. Junction or Pull Boxes:

1. Pull and junction boxes shall be installed as shown, or provided as necessary to facilitate cable pulling in conduit runs or to limit the number of bends as specified herein. All boxes shall be permanently accessible and shall be placed only at locations approved by the Designer.
2. The drawings do not necessarily show every pull or junction box that is required to complete the work in an approved manner. The Contractor shall add and provide all pull boxes as required by Code, standards or as specified.



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3. In suspended ceiling spaces, all boxes shall be supported from the structure; and shall not be supported by the ceiling or its suspension system.

### 3.7 WIREWAYS

- A. Four-sided cable trough for communication cabling in exterior areas and areas where cabling needs additional protection... Intended to support and provide protection against circulating dust, dirt and dripping non-corrosive liquids.
- B. Install wireways in accordance with manufacturer's instructions and recognized industry practices, and ensure that the installed system complies with requirements of the NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
- C. Install system at locations indicated on the Drawings. Field verify route prior to installation.
- D. Connection fittings and couplers shall be from the same manufacturer and shall maintain the same NEMA rating as the wireway.
- E. Provide NEMA rating as indicated on drawings.

### 3.8 CABLE TRAYS AND BASKET TRAYS

- A. General:
  1. Provide cable tray product and installation in accordance with the applicable provisions of the NEC pertaining to construction and installation of cable tray and cable channel systems (Article 318).
  2. Install cable tray in accordance with provisions of NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance" pertaining to installation of cable tray systems.
- B. Installation:
  1. Fill ratio: Cable tray may be filled to 50%. Size cable tray to accommodate future changes or additions.
  2. Load span criteria: Install and support cable management system in accordance with NEMA VE-1 (2002) with Safety Factor of 1.5.
  3. Splice plates: The resistance of fixed splice connections between and adjacent section of tray shall not exceed .00033 ohms.
  4. Accessories: Special accessories shall be provided as indicated to protect, support and install a cable tray system.
  5. Install cable tray as indicated in accordance with recognized industry practices. Ensure all cable tray equipment complies with requirements of NEC, applicable portions of NFPA 70B, and NECA's "Standards of Installation" pertaining to general electrical installation practices.



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6. Provide sufficient space encompassing cable tray to permit access for installing and maintaining cables.
7. Wire "basket type" mesh tray shall not be cut with standard bolt cutters. Use approved manufacturer recommended cutting tools to assure edges are square and finished and mate properly with connecting materials. Submit tool data sheet with product submittal before start of work. Deburr and file edges to assure smooth edge. Paint exposed edges of cut tray to match tray finish to prevent oxidation.
8. All work shall conform exactly to manufacturer recommended installation instructions and training.
9. Provide all bends, fittings, dropouts and other accessories as indicated on drawings or as required to provide complete cable tray system.
10. For cable tray, provide all straight, reducing or expanding corner bends, tees, crosses, internal and external radiuses as shown on plans.
11. For basket tray, provide factory reducing or expanding corner bends, tees, crosses, internal and external radiuses OR field cut and bend wire mesh if provided within manufacturer recommended installation instructions.
12. Provide dropout fittings at each location cable will exit down through the tray. Coordinate each location in advance with the A/E. Provide as indicated on plans.
13. Coordinate cable tray with other electrical work as necessary to properly interface installation of wire basket runway with other work.

C. Grounding:

1. A supplementary cable tray ground shall be installed along all metallic cable trays and basket trays:
  - a. Provide #6 AWG green insulated bonding conductor along all cable tray sections.
  - b. For runs longer than 300 feet use insulated green #1 AWG.
  - c. Conductors shall be continuous from end of run to nearest communications grounding busbar. Multiple runs are permitted.
  - d. Ground each section of tray with approved split-bolt ground fitting to bonding conductor.
  - e. Remove paint from all surfaces at each bonding point to assure positive connection.
  - f. Provide ground connection at minimum 6 foot intervals. Each section of tray shall contain at least one ground connection.
  - g. Affix bonding conductor to outer side of basket tray 2 inches above tray bottom.
  - h. Cable tray and basket tray grounding shall be separate from grounding systems for racks and cabinets unless specifically indicated on the drawings or approved in writing from Microsoft engineer.
  - i. No splices are permitted without written approval from Engineer of Record.

D. Testing:

1. Test aluminum cable tray and wire basket support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance



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with specified maximum grounding resistance. See NFPA 70B, Chapter 18, for testing and test methods.

### 3.9 FIBER DUCT

#### A. General:

1. Provide fiber duct product and installation in accordance with the applicable provisions of the NEC pertaining to construction and installation of cable tray and cable channel systems (Article 318).
2. The fiber duct system shall be UL listed and utilize materials which exhibit flame resistant characteristics, tested in accordance with UL94.

#### B. Installation:

1. Fill ratio: Fiber tray may be filled to 50%. Size cable tray to accommodate future changes or additions.
2. Load span criteria: Install and support cable management system in accordance with NEMA VE-1 (2002) with Safety Factor of 1.5.
3. Covers and Accessories: Covers and other special accessories shall be provided as indicated to protect, support and install a cable tray system.
4. Install cable tray as indicated in accordance with recognized industry practices.
5. Install cable tray per manufacturers recommended installation practices and procedures. Installer shall provide time for review of such installation practices and not begin work until this condition is established.
6. Provide all bends, fittings, spillovers, corners, tees, crosses, mounting brackets, covers and other accessories as indicated on drawings or as required to provide complete fiber duct system.
7. Coordinate cable tray with other electrical work as necessary to properly interface installation of fiber duct runway with other work.

### 3.10 SLEEVES

- A. Sleeves may be filled to 50% where less than 24" long.
- B. Provide plastic bushings on all conduit stub outs and sleeves. Do not install cables in conduits until bushings are installed on the ends of the conduits.
- C. All sleeves penetrating fire-rated walls, floors or structures shall be provided with firestopping materials in accordance with this Section, Division 0, Division 1 and Section 27 00 10 General Provisions for Communication Systems.
- D. Vertical sleeves for communication use shall terminate not less than 3 inches below the floor and not less than 3 inches below the ceiling of the floor above. Vertical sleeve shall terminate not less than 3 inches above finished floor unless otherwise indicated.



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- E. Where required, set sleeves in forms before concrete is poured. Lay out penetration and sleeve openings in advance, to permit provision in work Core drill or cut wall or floor as necessary where sleeves were not installed or incorrectly placed before wall or floor construction. Do not penetrate structural members.
- F. Provide firestopping where sleeves penetrate fire-rated floor or wall assemblies or where required to seal wall or floor from air, smoke or fumes.
- G. Provide sealants where passage of air, smoke or fumes is required to be mitigated.
- H. Sleeves through floors shall be watertight and to extend 2 inches above floor surface.
- I. Where raceways passing through openings are exposed in finished rooms, finishes of filling materials shall match and be flush with adjoining floor, ceiling, and wall finishes.
- J. Sleeves shall not be provided for slabs-on-grade unless specified or indicated otherwise.
- K. Future use: Identify unused sleeves and slots for future installation

### 3.11 INNERDUCT

- A. Install all innerduct in accordance with manufacturer's recommendations.
- B. Where innerduct is installed within conduit, provide quantity as indicated on drawings.
- C. When routing through corridors, place innerduct in the supports indicated on the drawings.
- D. When routing vertically through telecommunications rooms, support innerduct on vertical cable support (such as runway) and fasten using cable ties.
- E. When routing horizontally through telecommunications rooms, support innerduct on overhead cable support and fasten using cable ties. Install cable ties at 24-inch intervals.
- F. Label innerduct at both ends. The label shall be visible and readable from a distance of six feet.

### 3.12 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-D for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.



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- B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- I. Pathways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
  - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
  - 3. Arrange pathways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
  - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
  - 5. Change from ENT to GRC or IMC before rising above floor.
- J. Stub-ups to Above Recessed Ceilings:
  - 1. Use EMT, IMC, or RMC for pathways.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.



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- N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- P. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
- R. Surface Pathways:
  - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
  - 2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
  - 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
  - 1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
  - 2. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
  - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- T. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
- U. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:



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1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where an underground service pathway enters a building or structure.
  3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- W. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
  2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
    - d. Attics: 135 deg F (75 deg C) temperature change.
  3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
  4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.
- Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a rain tight connection between box and cover plate or supported equipment and box.



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- Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- CC. Set metal floor boxes level and flush with finished floor surface.
- DD. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.13 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 05 37 "Firestopping For Communications Systems"

3.14 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping." and in Section 27 05 37 "Firestopping For Communications Systems."

3.15 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.16 TEXTILE INNER DUCT INSTALLATION

- A. Provide textile inner duct in conduit and wire ways, and place textile inner duct within and under cable trays using continuous unspliced lengths of textile inner duct between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.
- B. Make a 2" incision, approximately 18" from the end of textile inner duct. Pull out and cut off approximately 2 feet of pull-tape. Thus allowing the pull tape ends to retract back into the cells.



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- C. Using approximately 6 feet of pull tape, tie a non-slip knot to the incision. Then tie 3 to 6 half-hitch knots down to the end of textile inner duct. Apply black vinyl tape over all knots and the end of textile inner duct. Using a Bow Line knot tie a swivel to the end of 3 feet pull tape. For multi-pack installations one swivel is sufficient, but stagger each textile inner duct.
- D. Using a Bow Line knot, attach the pull rope located in the rigid conduit to the other end of the swivel. Install textile inner duct – ensuring that no twist is introduced to the inner duct.
- E. Provide suitable textile inner duct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.
- F. Textile Inner duct Mountings, Hangers and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support.
  - 1. Design & install hangers and other similar fittings adequate to support loads and so as to not damage inner duct.
  - 2. Do not fasten textile inner duct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires
  - 3. When appropriate, use the following cable ties to secure textile inner duct through previously created incisions:
    - a. Plenum areas: plenum-rated plastic or stainless steel
    - b. Non plenum areas: Conventional flame-retardant nylon ties
    - c. Underground locations: Conventional plastic cable ties
- G. Maintenance Hole and Hand Hole Installation:
  - 1. At locations where textile inner duct will be continuous through a manhole or hand hole, allow sufficient slack so that the inner duct may be secured to the side of the vault maintaining the minimum bend radius.
  - 2. At maintenance holes serving as the junction location, pull the exposed end of the inner duct to the far end of the vault, install termination bag, and secure to the vault.
- H. Cable Tray and Runway Installation: Cut incisions every 24 inches into the edge of the textile inner duct and cable wrap to one side of vertical ladder rack or horizontal ladder-type cable tray at each incision.

### 3.17 PENETRATIONS

- A. Seal all conduit and textile inner duct entering structures at the first box or outlet to prevent entrance into the structure of gases, liquids or rodents.
- B. Inspect fire stopping installation by others between building structure and conduit, wire way, and cable tray to verify integrity of installation.



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- C. Exposed Textile Inner Duct Penetrations: Install conduit sleeves or fire barrier sealing systems in all openings where open and exposed textile inner duct passes through fire-rated walls and floors. After installation, install intumescent fire barrier penetration sealing material (Hilti system) between textile inner duct and sleeves or fire barrier system.
- D. Raceway Penetrations: After textile inner duct installation, install intumescent fire barrier penetration sealing material (Hilti system) between textile inner duct and conduit or wire way at all exposed penetration locations.
- E. Protect adjacent surfaces from damage during water seal or fire stop installation. Repair any damage.
- F. Document entire installation process for future referral.

**END OF SECTION 27 05 28**



## **SECTION 27 05 29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS**

### **PART 1 - GENERAL**

- A. Cable hooks (J-hooks) are a suitable alternative to cable tray ONLY when the planned capacity of the pathway system is fifty (50) cables or fewer.

#### **1.2 SUMMARY**

- A. This section shall govern the products and installation of hangers and supports for communications systems.
- B. Section Includes:
  - 1. Non-Continuous Cable Support (J-Hooks) Systems.

#### **1.3 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 27 00 00 "Communications" including all referenced codes, standards and guidelines.

#### **1.4 SUBMITTALS**

- A. The following submittals are due at the Pre-construction Phase, in accordance with submittal requirements in Section 27 00 00 "Communications".
  - 1. Product Information
    - a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
    - b. Provide manufacturer's product information cut-sheet or specifications sheet with the specific product number identified or filled out.
  - 2. Shop Drawings
    - a. In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8" = 1'-0") indicating routing of cable and means of support (where supported by cable tray vs. j-hooks).
  - 3. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:



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- a. Include scaled j-hook layout and relationships between components and adjacent structural, electrical, and mechanical elements.
  - b. Vertical and horizontal offsets and transitions.
  - c. Clearances for access above and to side of j-hooks.
  - d. Vertical elevation of j-hooks above the floor or below bottom of ceiling structure.
  - e. These locations shall be fully coordinated with all other trades.
- B. The following submittals are due at the Post-construction Phase, in accordance with submittal requirements in Section 27 00 00 "Communications".
  - 1. Record Drawings
    - a. In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8" = 1'-0") indicating routing of cable and means of support. Design drawings or shop drawings modified in the field will not be accepted.
  - 2. Manufacturer and Maintenance Manuals for all installed equipment
    - a. Provide manufacturer's product information cut-sheet or specifications sheet with the specific product number identified or filled out.

## PART 2 - PRODUCTS

### 2.1 NON-CONTINUOUS CABLE SUPPORT (J-HOOK) SYSTEMS

- A. Non-continuous cable supports
  - 1. J-hooks shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables and be UL Listed.
  - 2. J-hooks shall have flared edges to prevent damage while installing cables.
  - 3. J-hooks shall have the manufacturer's name and part number stamped on the part for identification.
  - 4. J-hooks sized 1-5/16-inches and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable, reusable, and suitable for use in air handling spaces.
  - 5. J-hooks shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
  - 6. The minimum size for the main J-hook pathway shall be 4". Where cabling is installed within and is intended for an individual room or area, the minimum size J-hook shall be 2". The size or dimension of this J-hook pathway shall not be reduced based on any factors.
  - 7. 1-5/16-inch J-hooks may be installed to support the excess cable slack for wireless access point locations or other similar uses as approved by Owner or Owner representative.
  - 8. Product: J-hooks ERICO CADDY CAT LINKS models CAT32HP, CAT48HP, CAT64HP or B-Line Systems models BCH21, BCH32, BCH64 or approved equals.



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9. Independent support attached to structure on both ends Product: Erico CADDY  
Independent Electrical Drop Wire Securing Clips (P/N EC311)

### PART 3 - EXECUTION

#### 3.1 HOOK SYSTEM INSTALLATION

- A. Installation and configuration shall comply with TIA-569-C, NPFA 70, and the manufacturer's installation instructions.
- B. Install cables using techniques, practices, and methods which are consistent with Category 6A and optical fiber cabling and that supports their performance of completed and linked signal paths end-to-end.
- C. J-hooks shall be located at intervals of 60-inches or less.
- D. J-hooks shall be selected to accommodate the immediate and anticipated future quantity and weight of cables. Size j-hooks to allow for a maximum of 25% future capacity.
- E. Steel, masonry, independent rods, independent support wires or other structural parts of the building shall be used for cable support attachment points up to the total weight for which the fastener is approved. Rods or wires that are currently employed for other functions (e.g. suspended ceiling grid support) shall not be utilized as attachment points for j-hooks.
- F. Cable hooks shall be installed such that cable slack between supports is a minimum of 6-inches above ceilings.
- G. Provide adequate j-hooks to ensure telecommunications cabling is a minimum of 6-inches from light fixtures and power conduits.
- H. Where telecommunications cabling is being supported by j-hooks, provide a cable hook at every change in direction.
- I. J-hooks shall be installed in a conveniently accessible location.
- J. Route cabling such that a minimum of 48-inches is provided between cabling and electric motors or generators.

**END OF SECTION 27 05 29**



**SECTION 27 05 43 - UNDERGROUND CONDUITS AND DUCT BANKS FOR COMMUNICATIONS SYSTEMS**

**PART 1 - GENERAL**

**1.1 SECTION INCLUDES**

- A. The work required under this Section consists of providing all underground ducts and raceways for communication systems for the project as indicated on Plans or in this Specification.
- B. This section includes both site underground conduit and duct banks exterior to the building proper as well as underground conduits under the building slab and within the building envelope.
- C. Trenching and backfilling of trenches and ditches.
- D. See Specification Section 27 05 45 for underground communication vaults and spaces for communication systems. Vaults are considered part of the underground duct system.

**1.2 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. All general provisions of Section 27 00 00 Communication Systems shall apply to this Section, unless otherwise noted. Where modified, the modification will supersede the original condition.
- C. Related Work Specified Elsewhere:
  - 1. Section 01 33 00 Submittal Procedures
  - 2. Section 27 05 28 Pathways for Communication Systems
  - 3. Section 27 05 45 Underground Vaults and Spaces for Communications Systems
  - 4. Section 27 05 53 Labeling for Communication Systems
  - 5. Section 27 13 13 Communications Copper Backbone Cabling
  - 6. Section 27 13 23 Communications Optical Fiber Backbone Cabling
  - 7. Section 31 22 00 Earth Moving

**1.3 REFERENCES**

- A. All documents referenced in Section 27 00 00 Communication Systems are hereby incorporated by reference within this Section.



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- B. The publications listed below, including addenda, revisions, updates and errata, form a part of this Specification to the extent they are referenced. Materials are only referenced by their basic designations.

1. UL 651-95 Schedule 40 and Schedule 80 Rigid PVC Conduits.
2. UL651A-95 Type EB and A Rigid PVC Conduit and HDPE Conduit
3. UL 797-93 Electrical Metallic Tubing.
4. ASTM D 3350 Specification for Polyethylene Plastic Pipe and Fittings Material.
5. ASTM F 2160 Specification for Solid Wall HDPE Conduit.
6. NEMA TC 7 Smooth-Wall Coilable Polyethylene Conduit.
7. NEMA TC 6 and 8 PVC Plastic Utilities Duct for Underground Installations.
8. ANSI C80.2 Standard for Rigid Steel Conduit.

#### 1.4 REGULATORY REQUIREMENTS

- A. All Work shall conform to the requirements of NFPA 70.
- B. All Work shall conform to the requirements of all Federal, State and Local Electrical and Telecommunications Regulations.

#### 1.5 DESCRIPTION AND GENERAL SPECIFICATIONS

- A. Provide all labor, materials, tools, equipment, and services required to complete the work described herein and shown on the drawings and as required to provide a fully operational system.
- B. Raceways and other materials and appurtenances shall be UL listed, approved and suitable for the environment where installed.
- C. The drawings, which constitute a part of these specifications, indicate the general route of the pathway systems. Contractor shall verify existing field conditions and coordinate exact routing, location, distance and levels and other work of this Section with other trades prior to installation.
- D. Notify the Designer or Owner's Representative of any changes due to conflicts with other trades work, or due to any other reason other than of a minor nature prior to proceeding with work.
- E. Make necessary provisions for storage of materials and equipment at the site to ensure the quality and condition of the product to be installed. Use only materials and products that are new, free of defect, and which arrive unopened and in the original container at the jobsite.
- F. Notify the Owner's Representative at least two (2) full working days prior to covering of concealed communications work.



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1.6 DEFINITIONS

- A. Outside plant - telecommunications infrastructure designed for installation exterior to buildings.
- B. Underground - below the native or finished surface of the earth. For purposes of this section, "under-slab" means within the building envelope and under the finished floor surface and "site" designates structures or concrete outside the building and contained generally under dirt, paving, streets, or outside structures.
- C. Vault - means a structurally solid enclosure above or below ground with access limited to personnel qualified to install, maintain, operate, or inspect the equipment or cable enclosed. The enclosure may have openings for ventilation, personnel access, cable entrance, and other openings required for operation of equipment in the vault. (NESC, C2-1997)

NOTE: A vault as used in this Specification Division is used as a general term to include maintenance holes, manholes and hand holes and other indicated underground enclosures.

- D. Maintenance hole - a telecommunications vault located in the ground or earth as part of an underground duct system and used to facilitate placing, connection and maintenance of cables as well as the placing of associated equipment, in which it is expected that a person will enter to perform work. (TIA 569, TIA 758)
- E. Manhole - an underground sewer, boiler, pipe, conduit, drain, or underground chamber in which person may enter or access by an outdoor aperture.

NOTE: As used in this Specification Division, the terms vault, maintenance hole and manhole shall be synonymous and interchangeable with one another. Where used herein, use of one term shall also include the other; although manholes are traditionally deeper enclosures used for mechanical, sewer or electrical systems. The common use of the term "manhole" to mean any underground vault with a lid or cover is included herein to provide for this vernacular use.

- F. The term "hand hole" means an enclosure identified for underground system use, provided with an open or closed bottom, and sized to allow personnel to reach into, but not enter, for the purpose of installing or maintaining equipment or wiring. (NEC, Article 100)

1.7 ABBREVIATIONS AND ACRONYMS

- A. See specification 27 00 00 Communication Systems Section on Abbreviations and Acronyms.



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1.8 SUBMITTALS

- A. Submittals shall be prepared and delivered in accordance with Section 01 33 00 and Section 27 00 00 Communication Systems in sufficient detail to show full compliance with the specification.
- B. Manufacturer's Catalog Data shall be submitted for the following items at minimum:
  - 1. Raceways.
  - 2. Fittings and related hardware.
- C. Data shall include a complete list of parts, special tools, and supplies with source of supply

PART 2 - PRODUCTS

2.1 COMMUNICATIONS CONDUITS

- A. Non-Metallic Conduit
  - 1. Type: PVC Schedule 40 conduit.
  - 2. Size: 4", 5" or as indicated on drawings.
  - 3. Listing: UL stamp or label on each conduit length.
  - 4. Manufacturer: Carlon Plus 40 or approved equal.
- B. Conduit Elbows and Bends
  - 1. Type: PVC Schedule 40
  - 2. Nominal Size: 4", 5" or as indicated on drawings.
  - 3. Bend Types: 90°, 45°, 30°, 22-1/2°, or 11-1/4° factory-made bends
  - 4. Radius: Special radius. 90° factory bend shall contain 60" radius, and 45°, 30°, 22-1/2°, or 11-1/4° bends shall be 48" radius.
  - 5. Manufacturer: Carlon or approved equal.
- C. Conduit Fittings and Spacers
  - 1. Couplings: Standard PVC Schedule 40
  - 2. Manufacturer: Carlon or approved equal.
- D. Solvent:
  - 1. PVC cement as recommended by the conduit manufacturer.
- E. Compatibility
  - 1. All conduit, bends, fittings and solvent shall be by same manufacturer to assure size and application consistency.



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2.2 TRENCH DUCT / CABLE TROUGH

- A. Provide support for Cable Tray within the Cable Trough. Cooper B-Line DB10-28 & DB10-36.
- B. Shall be Cast In Place concrete with fiber-lite lids or Pre-Casts Concrete with fiber-lite lids.

2.3 DUCTBANKS:

- A. Conduit Spacers/Supports:
  - 1. Description: High-density plastic interlocking spacers/supports.
  - 2. Size" 4", 5" or as required by plans.
  - 3. Manufacturer: Underground Devices Inc.(WUNPEECE) or approved equal
- B. Warning Tape
  - 1. Duct banks equal to or greater than 10 inches in width:
    - a. Description: 6" wide metallic warning tape, orange in color.
    - b. Text: "CAUTION BURIED FIBER OPTIC LINE BELOW"
    - c. Locator type: Locator not required with duct bank trace wire
    - d. Manufacturer: Scotch Buried Barricade Tape 370 or approved equal.
  - 2. Duct banks less than 10 inches in width:
    - a. 3M #407- 3 inches wide
    - b. Orange with Buried Fiber Optical lettering
    - c. Locator wire integral to warning tape. No separate trace wire required.
- C. Locator or Tracer Wire:
  - 1. Construction: Copper tracer wire
  - 2. Size: #12 AWG
  - 3. Manufacturer: Performance Wire & Cable or approved equal.

2.4 SUBDUCTING

- A. Innerducts
  - 1. Construction: Precision-extruded PVC resin
  - 2. Sizes: 3/4" to 2" diameter. Provide as indicated on plans.
  - 3. Pull-tape: Provide with Kevlar pull tape for 1" and greater diameters.
  - 4. Fire-rating: Riser-rated
  - 5. Markings: Footages shall be sequentially marked.
  - 6. Manufacturer: Carlon Riser-guard or approved equal.



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2.5 DUCT SEALANT

- A. Blank, fiber optic simplex, duplex and triplex duct or as sized to meet condition.
- B. Tyco Jack Moon or approved equal.

2.6 PULL STRINGS AND CORDS

- A. Shall be provided with Greenlee or equal continuous conduit measuring tape in each duct.
- B. Contractor shall install Greenlee 900# pull tape (numbered) in each conduit and secure it at both ends.

2.7 BACKFILL MATERIAL:

- A. As specified by Soils Report and Civil Engineer.

PART 3 - EXECUTION

3.1 GENERAL:

- A. The number, size, raceway duct material and arrangement shall be as indicated on Drawings and/or as specified herein.
- B. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.
- C. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations
- D. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.
- E. Remove surplus material and debris from the job site and dispose of legally.
- F. Conduits shall be provided in the size and types as indicated on the Plans.
- G. Refer to Civil Plans for coordination with other underground utilities and structures. Coordinate with Civil Engineer or Representative prior to trenching and placement of structures. Avoid conflicts with existing utilities. Notify Designer or Owner's Representative immediately of any conflicts for resolution prior to proceeding with work.



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- H. Communication conduits, duct banks, and other pathways and spaces shall be routed exactly as indicated on Plans and contain no deviations by the Contractor, unless such deviation is authorized in writing by the Designer or Owner's Representative.
- I. In the event a conflict with an underground utility or other condition is discovered during the execution of the work of this Section, and such conflict prevents installation of the system as indicated, Contractor shall immediately notify the Designer or Owner's Representative of such conflict for resolution prior to proceeding with work.
- J. Cut conduit ends square and ream to remove burrs and sharp ends.
- K. Extend conduits the maximum distance into fittings, couplings, and/or connectors. Tighten fittings securely and seal watertight.
- L. A minimum of 2'-6" depth (measured from top of concrete encasement to finished grade or from finished floor in under slab applications) is required. In no case shall the top of concrete be less than 3 inches below the frost line of the area unless noted otherwise. Where deeper depths are indicated, locate ducts at the deeper elevation.
- M. Conduit runs shall contain no continuous sections longer than 400 feet. Contractor shall notify Designer or Owner's Representative immediately if the above distance, including adjustments, is exceeded. Where these distances, with reductions, are exceeded, manholes or hand holes shall be provided. Compliance with this provision does not discharge the Contractor from adherence to any cable pulling tension requirements herein this Specification; such requirements remaining in full force and effect and separate from this subparagraph.
- N. Conduit runs shall be installed as directly as possible between any two points and as indicated on drawings. Where conduits are provided between vaults, maintenance holes, hand holes or other spaces, they shall exit and enter on the two nearest opposing faces of the vaults, maintenance holes, hand holes or other space unless otherwise noted.
- O. Conduit and fittings shall comply with vibration isolation installation requirements.
- P. Conduit entrances at opposite ends, whether on an opposite end or side wall, of a maintenance hole or hand hole shall be at the same elevation and in the same position at each end. Each conduit leaving a maintenance hole or hand hole in any position shall enter the next maintenance hole or hand hole at the same relative position. Conduits shall enter and exit the manhole in a straight-line method, except where required to prevent a 90° bend external to the vault. In such cases it is permissible to exit at the far end of the maintenance hole or hand hole on the perpendicular wall. The remaining walls are to remain free of encumbrances to allow cable support and splicing operations.
- Q. Duct runs shall be graded to drain toward one or both terminal points of the duct run, except where entering buildings. Always slope conduits away from building structures. The slope shall not be less than 3 inches for every 100 ft. of length, unless otherwise shown on drawings. Provide slope from the higher terminal point to the lower terminal



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point without intermediate low spots that could pool moisture. Where terminal points are approximately at the same elevation, elevate the midpoints so as to provide drainage to each end. Where is impossible to avoid a swale or low point, Contractor shall immediately notify the Designer or Owner's Representative and obtain direction before proceeding further.

- R. Where turned up inside a building, all conduits shall be stubbed to exactly 4 inches above finished floor. Conduits shall be installed as close to a wall as practicable and be spaced evenly and neatly. Install end bells and plugs on to protect cable and prevent dirt and debris from entering conduits.
- S. The Contractor shall securely anchor the conduits to the bottom of the trench at ten-foot intervals to prevent the ducts from floating of during pouring of the concrete. Where spacers are used, the spacers may be anchored to meet this provision.
- T. After placement and anchoring, the entire duct bank shall be covered with no less than 3 inches of sand, followed by encasement of the top and sides with 6-inches of red concrete slurry. This provision is not required for conduit duct banks under the building slab, inside the building proper unless indicated otherwise.

### 3.2 NON-METALLIC CONDUIT

- A. Non-metallic conduit shall be used for all underground raceways except where rigid conduit is indicated or required.
- B. Non-metallic conduit fittings shall be by conduit manufacturer and installed per manufacturer's directions. All conduit and fittings shall be solvent cemented in applications in accordance with instructions from the manufacturer. Straight section couplings shall be staggered vertically and horizontally.
- C. During stockpiling, protect from deformation. Provide so that all conduits are perfectly circular in shape at time of installation. Replace all conduits not meeting this provision prior to encasement at no additional cost to owner.
- D. Comply with manufacturers requirements for bending and cutting.
- E. Where conduits terminate in vaults, maintenance holes or hand holes, provide with end bells flush with inside wall of manhole or vault.
- F. Provide Schedule 40 PVC for typical underground installation.
- G. Provide Schedule 80 Type EB or DB PVC where installing under public roadways.
- H. Provide threaded adapters where connecting PVC to rigid metallic conduit.



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3.3 INNERDUCT

- A. Install innerduct as indicated on Plans.
- B. For any conduit indicated to contain one or more innerducts, contractor shall populate the entire conduit with additional 1" innerducts for future use whether additional innerducts are indicated or not. Failure to comply with these conditions shall result in placement of the additional innerduct by contractor at no cost to owner. In addition, Contractor shall reimburse the client for any incurred costs to remove, replace and re-terminate any placed optical fiber.
- C. Innerducts shall be plugged at each building entrance with material capable of withstanding a 3 m (10 feet) head of water (5 psi).

3.4 UNDERGROUND CONDUIT SWEEPS AND BENDS:

- A. Conduits shall have no more than 180 degrees of cumulative bends between pull points. The 180-degree maximum shall include kicks and offsets. Where it is not possible to construct a section of conduit within the 180-degree sweep maximum, an intermediate maintenance or hand hole shall be installed.
- B. Except where noted below, all sweeps and bends shall be factory-manufactured bends with a minimum radius of 15 times the outside diameter of the conduit or as specified in Part II.
- C. Where parallel conduits are installed within a ductbank, the minimum sweep radius of each conduit shall be the same that of the largest conduit. For full quarter bends, conduits shall be bent and placed in a concentric manner, with the inside conduit having a bend radius of at least 10 times the largest conduit.
- D. An individual bend or sweep shall not exceed 90 degrees.
- E. Two 90-degree sweeps separated by less than 20 feet is not permitted without written approval of the Designer or unless otherwise indicated on drawings.
- F. Where unique construction requirements for bend radius or arc length do not permit the use of factory-manufactured sweeps, sweeps may be field-manufactured using factory-recommended equipment upon written approval by the client. The internal diameter of the sweep shall not be changed during the sweep field-manufacturing process.

3.5 SEPARATION FROM OTHER UTILITIES

- A. Follow the requirements of the NESC and NEC but minimally separate facilities as follows:
  - 1. Power up to one KVA:
    - a. 12 in. of well- packed earth



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- b. 4 in. of masonry
    - c. 3 in. of Concrete
  - 2. Gas, Oil, Water, etc.:
    - a. 12 in. when parallel
    - b. 6 in. when crossing
  - B. Where underground crossings are known, field verify horizontal and vertical locations prior to excavation and placement of conduit. Any profile changes and existing utility line crossings are to be as built on drawings showing: type of line, size, and depth below the surface.
  - C. Conduit or duct banks shall maintain 1 foot vertical and 1 foot horizontal separation from other utility lines.
  - D. Underground Clearance: Where underground conduits run parallel with pipelines, a one foot (1') minimum clearance shall be maintained, and at crossings, a one foot (1') minimum clearance will be maintained below the bottom of the pipes. Conduits should cross under existing pipes when practical and reasonable.
- 3.6 CONDUIT SPACERS/SUPPORTS:
- A. Place supports on eight (8) foot centers if encased in concrete and five (5) foot centers otherwise. Interlock spacers horizontally only. Stagger spacers encased in concrete at least six (6) inches vertically.
  - B. Where multiple communication conduits occupy the same trench or excavation, interlocking supports or spacers shall be used. They shall be the standard product of the duct manufacturer and provided for the size, quantity and type of duct used. Conduits shall be separated in a manner such that the space between adjacent conduit walls, whether on a vertical and horizontal plane, is no less than two inches. Such spacing shall remain consistent throughout the entire run. Such supports or spacers shall be located at five-foot intervals. Conduits shall be stacked as indicated on the Plans, and always in a manner so that conduit centerlines are aligned both horizontally and vertically, unless noted otherwise.
- 3.7 STEEL REINFORCEMENT
- A. Provide steel reinforcement in each ductbank just below the lowest row of ducts where the duct run spans disturbed earth, where it enters manholes and buildings (out to 1.8 m), and where it crosses under heavily traveled roadways. The spacing between ducts is 2" (50mm) in all directions.
  - B. Where the duct bank enters a manhole, provide reinforcement in the duct bank base as directed by the Owner's Representative. Provide extra reinforcement where duct bank crosses a roadway, an excavation, and unstable or compacted earth.



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3.8 CONDUIT STUBS

- A. Stubbed Through Floor: Conduits to be stubbed up out of the finished floor shall be stubbed up at six inches (6") above the finished grade or equipment housekeeping pad.

3.9 DUCT PLUGS AND SEALS

- A. Ducts shall be capped with manufactured caps or plugs when installation is temporarily discontinued or not being directly worked on, and upon final completion of the work. Tape or TERM-A-DUCT is not permitted for use as an end cap or cover.
- B. Conduit penetrations into buildings or through above ground foundations, shall be sealed with duct seal or conduit sealer to prevent gas or water entry.
- C. Conduits and innerducts, including those containing cables, shall be plugged at each end, including the building with "JackMoon" or equivalent duct seal, capable of withstanding a 10-foot head of water (5 psi).

3.10 CONDUIT MARKERS AND WARNING TAPE

- A. A warning tape shall be installed at 12" above the top of the duct bank. In no case shall it be less than 12" below finished grade or slab.
- B. Install tape flat and centered on duct bank or conduit without twists or bunching. Install so that lettering faces up and is easily visible upon removal of earth above.
- C. Where conduits terminate in the ground for future connection, conduits shall be capped and marked with an electronic marker.

3.11 PULL ROPES

- A. Installed innerduct shall be provided with incremented nylon pull tape in each innerduct. Pull tape shall be rated for a minimum of 300 pounds of pulling tension.
- B. Where cable is pulled into any conduit of innerduct, provide pull rope with cable installation.
- C. Provide all pull ropes, cords, or strings with minimum 10 feet slack at each end. Secure each end of rope, cord or string to ring provided for the purpose.
- D. All conduits shall have polypropylene 2-ply pull cords, each minimum 1/4" with 900 lb. minimum pulling tension rating installed in all conduits, including those with installed cabling. Firmly secure pull cords at each end.



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3.12 CONDUIT TESTING AND CLEANING

- A. After installation, and within five days prior to releasing conduit for cabling installation, each underground 4" conduit shall be tested for damage and cleaned as follows:
  - 1. For 4" PVC:
    - a. Hand pull a wood mandrel 3-3/4" diameter by 4-1/2" long through the conduit.
    - b. Follow wood mandrel with a 4-1/4" long stiff bristle brush.
  - 2. For 5" PVC:
    - a. Hand pull a wood mandrel 4-3/4" diameter by 4-1/2" long through the conduit.
    - b. Follow wood mandrel with a 5-1/4" long stiff bristle brush.
- B. Use related size mandrel and brush for larger and smaller conduit sizes, following the same procedure.
- C. Clean each conduit a minimum of two times in the same direction and swab with clean rags until the rag comes out of the conduit clean and dry. Swab away from buildings for conduit sections connected to buildings.
- D. After conduits are made acceptable and clean, install plastic plugs at each conduit end to prevent egress of water or debris material until cables are pulled.
- E. Ensure that surplus material and debris is removed.

3.13 CABLE TROUGH /TRENCH DUCT INSTALLATION

- A. Provide and install cable trough / trench duct sections as required for the project in coordination with the civil contractor and utilities contractors.
- B. Coordinate grading and trench elevations to properly locate top of trough to grade with civil grading plan and civil grading contractor prior to digging trenches.
- C. Provide cable tray support as recommended by the manufacturer for the tray to be located within the trough.
- D. Provide grounding in accordance with specifications section 27 05 26.

3.14 EXCAVATION AND TRENCHING

- A. Excavate to bottom elevation of duct bank encasement and correct points of over excavation by returning trench to grade with mechanically compacted backfill to form a smooth trench bottom.
- B. Ensure that the entire bottom of excavation is firm, level, solid and at a uniform density according to recommended good practices contained within ANSI-TIA-EIA 569 section 10.



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- C. Excavate to minimum width consistent with stability of trench side walls and provide shoring as required by code.
- D. All excavation, including trenching, and backfilling shall conform to:
  - 1. For exterior site work – Section 31 22 00 Earth Moving.
  - 2. Under-slab underground conduit inside the building:
    - a. Comply with requirements of the project.
    - b. Geotechnical Report and Section 31 22 00 Earth Moving.

3.15 CONCRETE PLACEMENT

- A. By General Contractor

3.16 LABELING

- A. Affix a permanent tag or label on each conduit identifying conduit number, far-end location and footage distance. Conduit identification numbers shall be as indicated on schedule or detail on drawings.
- B. Vault labeling:
  - 1. Vaults shall be labeled as “COMMUNICATIONS” with 2-inch or larger cast or welded lettering.
  - 2. Affix an additional permanent cast or bronze engraved label on each vault lid with unique identifier as shown on plans. Utilize the client vault labeling schema as follows:
    - a. Service Provider Vaults:
      - 1) T-S-xxx Where:
        - a) “T” for Telecom
        - b) “S” for Service Provider
        - c) xxx = 3 character number starting with 0xx
    - b. Client Site Vaults:
      - 1) T-xxx Where:
        - a) “T” for Telecom
        - b) xxx = 3 character number starting with 1xx
    - c. Coordinate with the Owner to determine the last index number used on existing manholes. Do not repeat the use of existing manhole numbers.
    - d. Lettering shall be at least 30-point characters in size.

3.17 CONDUIT LABELING:

- A. Affix a permanent tag or label on each conduit identifying conduit number, far-end location and footage distance. Conduit identification numbers to be as indicated on schedule or detail on Drawings.



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3.18 AS-BUILTS:

- A. Contractor shall provide as built and record document information to Owner as specified in Division 27 00 00 Communication Systems.
- B. Indicate location of all underground routes, if different than original drawing.

**END OF SECTION**



## **SECTION 27 05 53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 SCOPE**

- A. Section shall consist of furnishing labor, equipment, supplies, materials, and testing to provide labeling and identification of the communications infrastructure as described on the Drawings and/or required by these specifications.
- B. This section includes minimum requirements labeling:
  - 1. Horizontal and backbone communication cables.
  - 2. Cabinets, racks, equipment frames, patch panels, interconnects, wiring and terminal blocks and enclosures, and other hardware and communication components in communication rooms and spaces.
  - 3. Workstation outlets.
  - 4. Equipment; including security card access and surveillance cameras, wireless access points, network equipment, etc.
  - 5. Broadband systems and components; and
  - 6. Other communication hardware and equipment as specified herein.

#### **1.2 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. All general provisions of Section 27 00 00 Communications, shall apply to this Section, unless otherwise noted. Where modified, the modification will supersede the original condition.
- C. Related Work Specified Elsewhere:
  - 1. Section 01 33 00 Submittal Procedures
  - 2. 27 00 00 - Communications
  - 3. 27 05 10 - Communications Firestopping
  - 4. 27 05 26 - Grounding and Bonding for Communications Systems
  - 5. 27 05 28 - Pathways for Communications Systems
  - 6. 27 05 53 - Identification for Communication Systems
  - 7. 27 05 43 – Underground Conduits and Duct Bank
  - 8. 27 11 19 - Communications Terminations Blocks and Patch Panels
  - 9. 27 15 13 - Communications Copper Horizontal Cabling
  - 10. 27 15 43 - Communications Faceplates and Connectors
  - 11. 27 16 19 - Communications Patch cords and Station Cords
  - 12. 27 21 33 - Wireless Access Points



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1.3 REFERENCES & STANDARDS

- A. All documents referenced in Section 27 00 00 Communications are hereby incorporated by reference within this Section.
  - 1. Emphasis shall be placed on articles specifying telecommunication termination hardware.
  - 2. Emphasis shall be placed on articles specifying termination of copper horizontal and backbone cabling.

1.4 DESCRIPTION AND GENERAL SPECIFICATIONS

- A. Provide all labor, materials, tools, equipment, and services required to complete the work described herein and shown on the drawings and as required to provide a fully operational system.
- B. All equipment shall be suitable for the environment it is installed.
- C. The drawings, which constitute a part of these specifications, contain detail information as to labeling; including, but not limited to; the method and placement of labels on faceplates and equipment, and naming and numbering conventions.

1.5 DEFINITIONS AND ABBREVIATIONS

- A. Refer to Section 27 00 00 "Communications" section 1.8 which provides information on Definitions and Abbreviations used in this and related sections.
- B. The term "workstation outlet" refers to a fixed connector in an equipment or outlet. It is part of the horizontal cabling distribution system within the building space where the occupants interact with telecommunications terminal equipment.

1.6 WORK BY OWNER

- A. Refer to Section 27 00 00 "Communications" which identifies Work by the Owner affecting the sub-system(s) covered by this section.

1.7 SUBMITTALS

- A. Submittals shall be prepared and delivered in accordance Division 01 Section 01 33 00 and Section 27 00 10 General Provisions for Communication Systems in sufficient detail to show full compliance with the specification.
- B. Manufacturer's Catalog Data shall be submitted for the following items at minimum:
  - 1. Labeling machines



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2. Label types to be deployed

- C. Prior to installation, the Contractor shall provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used and shall follow the standards detailed below.

1.8 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 "Communications" which identifies general quality assurance requirements for the project.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Labels shall be machine generated and be permanent.
- B. Each outlet shall be labelled with a unique identifier
- C. No handwritten or non-permanent labels allowed unless specifically noted otherwise.
- D. All labels and markings shall be physically and chemically resistant to damage that would make the label unreadable.
- E. Characters on all labels shall be Black printed on a background of contrasting color. Distribution frame layouts, color coding and numbering schemes are to be approved by Owner IT prior to installation.
- F. Labels shall match the Communications Outlet layout and Patch Panel design and shall be as large as practicable (up to 16-point) to fit properly.
  - 1. No lettering shall be smaller than 10-point.
- G. Cable labels shall be self-laminating, White/Transparent Vinyl and incorporate an integrated clear lamination which, when the label is wrapped around the cable, covers the printed part of the label.
  - 1. Labels shall be of adequate size to accommodate the circumference of the cable(s) being marked and properly self-laminate over the full extent of the printed area of the label.
  - 2. Labels used on larger cables (e.g., Copper Backbone) may be wrapped with clear non-removable tape.
- H. Manufacturers: Subject to compliance with specifications preferably with Traffolyte labels or as a minimum with an indelible label machine.



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I. Label Machine

1. Approved Label Machines:
  - a. Panduit Panther LS8E
  - b. Panduit Thermal Transfer

PART 3 - EXECUTION

3.1 GENERAL

- A. All cables, jacks, faceplates, patch panels, connecting blocks, racks, and cabinets shall be labeled with machine generated labels according to the specifications below and in accordance with TIA labeling standards.
- B. All Cables shall be identified and labeled AT BOTH ENDS with self-adhesive, self-laminating, with white matte finish printing area, clear plastic shield labels. Labels shall be placed within approximately 6" from termination point.
- C. Cable labels shall be wrapped around the cable (not a "flag").
- D. The printed identifier shall be covered by the clear laminating part of the cable label.
- E. Identification markings and systems shall be uniform.
- F. Contractor shall use Panduit Panther LS8E or Panduit Thermal Transfer printer for printing of labels. This will assure future integration with the Owner's Operations procedures.
- G. Number all workstation outlets starting at the leftmost outlet nearest the main room entrance and proceeding clockwise around the room unless otherwise indicated. Number using first the room number, followed by the outlet number as shown on the drawing and drawing sheet notes.
- H. The contractor shall label all outlets, patch panels, interconnects, wiring blocks and other termination hardware using permanent/legibly typed or machine-engraved labels. Industrial grade tape shall be used for all labels.
- I. The size, color and contrast of all labels should be selected to ensure that the identifiers are easily read.
- J. All labels shall be mechanically printed; no hand printed labels allowed for any component.
- K. Labels should be visible during the installation of and normal maintenance of the infrastructure. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat or ultraviolet light) and should have a design life equal to or greater than that of the labeled component.



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- L. Provide vinyl substrate with a white printing area and black print. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow – so that the labels are easily distinguishable.
- M. Labels shall be flexible vinyl or other substrates to apply easy and flex as cables are bent.
- N. Labels shall use aggressive adhesives that stay attached even to the most difficult to adhere to jacketing.

### 3.2 BUILDING AND ROOM IDENTIFIERS

- A. Telecommunications Room (TR)
  - 1. The TR number shall be based on the client room numbering
- B. Main Equipment Room (MER)
  - 1. The MER number shall be based on the client room numbering.

### 3.3 FLAT MODULAR PATCH PANEL

- A. Flat Modular Patch Panels used to terminate Horizontal Cabling shall be labeled following:
  - 1. All patch panels shall be labeled with a letter designation ¾" high black text on white background.
  - 2. All ports on patch panels shall be labeled in accordance with design documents using the compatible labeling system for the panel.
  - 3. Horizontal cabling: Ports for horizontal station cabling shall be labeled with the room number, outlet ID and jack designation.
  - 4. Refer to section pertaining to work area outlet labeling

### 3.4 CONDUIT AND RISER/BACKBONE CABLING AND TERMINATION HARDWARE

- A. Cables shall be labeled with wrap-around labels at both ends, and terminals on terminal blocks or panels shall bear the cable number.
- B. High-pair count copper backbone cables and all optical fiber cabling shall be labeled with a "To-From" designation and an overall cable number for identifying pairs.
- C. Copper pairs shall be labeled on wiring blocks in increments of 5 (5, 10, 15, 20) unless specified otherwise herein.
- D. "To-From" labeling shall include building number and telecommunication room number as applicable.



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- E. Cables to be labeled utilizing “cable sheath” tags (or equivalent).
- F. All riser cabling shall be labeled with the source and destination cabinet/rack, patch panel/block and port information. Labels shall be 2” width and font shall be as large as possible. Labels every 5 feet on conduits and every 5 feet and termination point each backbone cables with a unique identifying code as follows:
  - 1. XO MER ← FIBER CABLE DO NOT CUT → XD TR A
  - 2. where:
  - 3. XO - Floor Origination
  - 4. XD – Floor Destination
  - 5. MER – IT Room Origination
  - 6. TR A – IT room Destination
- G. Each Fiber Optic Patch Panel shall be clearly labeled with a unique identifying code to identify:
  - 1. The near end optical fiber adapter (e.g., coupler) letter.
  - 2. The used ports.
  - 3. The far end IDF room number.
  - 4. The far end coupler letter.
  - 5. Fiber type (e.g., M50 or SM)
  - 6. Far end used ports.
- H. The cable identifiers are to be secured to the front cover of the panel enclosure.
- I. Patch panel labels shall be visible from front of panel without opening panel cover.
- J. Place patch panel labels for fiber strands on manufacturer designated labeling areas.
- K. The labels material and hardware:
  - 1. Minimum 2.0"W x 2.0"L labels - Brady
  - 2. Ink ribbon for above labels - Brady PN: IP-R4307
  - 3. Brady IP300 printer - Brady PN: IP-300

### 3.5 HORIZONTAL COPPER CABLING AND TERMINATION HARDWARE

- A. Use manufacturer’s clear plastic designation strips on colored stock on 110 blocks.
- B. Label patch panels using computer or label-maker labels.
- C. Label the outlet number of station cables using commercial labels or tabs.
- D. Label distribution cables (copper and fiber) with commercial labels or tabs identifying “near and far destination”.



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- E. Label each cable at the termination point with a unique identifying code as follows:  
(Contractor to obtain Client Approval on labeling schema prior to cable pulling.)
1. 1AR2-A01 TO 2BR1-B01 (###)
  2. where:
  3. 1AR2= 1A the source Telecommunications Room Number designation (first number is floor number and second letter is IDF designation) and R2 is Rack Designation
  4. A01 = A is patch panel Location and 01 is port number
  5. 2BR1 = 1B the Destination Telecommunications Room Number designation (first number is floor number and second letter is IDF designation) and R1 is Rack Designation
  6. B01 = B is patch panel Location and 01 is port number
  7. ### = Pair Count
  8. MANY ALTERNATE OPTIONS FOR LABELLING GENERALLY CLIENT STANDARD SHOULD BE FOLLOWED WHERE POSSIBLE
- F. Numeric designation of horizontal cabling is associated with telecom spaces and shall utilize a "one-up" numbering scheme. For cabling associated with workstation, telephone, wireless LAN, DECT, Spectralink or other support systems the general convention shall be used:
1. MDF-1                      1000 series
  2. MDF-2                      2000 series
  3. Primary Cable Space 3000 series

NOTE: Cable spaces may be project specific. This labeling schema is primarily  
for on-site construction rather than manufactured components or  
buildings.  
(Contractor to obtain Client Approval on labeling schema prior to cable pulling.)

### 3.6 WORK AREA OUTLET AND HORIZONTAL CABLING

- A. The Communications Outlet shall be located in zones as indicated on detail drawings with a unique identifier. (Contractor to obtain Client Approval on labeling schema prior to cable pulling.)
- B. Horizontal Cabling
1. 2" x ½", printable area.
  2. Compatible with cabling that is .16" to .32" diameter.
  3. Labels shall be white in color.
  4. Shall be machine printed.
  5. Shall be Panduit:
    - a. Turn-Tell labels.



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3.7 POSITION NUMBER DETAIL

- A. Each Communications Outlet shall be labeled with a unique identifier.
  - 1. Each cable terminated at the Communications Outlet will be labeled with the same identifying code(s).
  - 2. Faceplates shall be labeled with ¼" high black text on white background as indicated on standard outlet details.
  - 3. Each individual Jack shall be installed with a color-coded Ortronics icon insert.

3.8 TELECOMMUNICATIONS BONDING AND GROUNDING:

- A. All telecommunications bonding and grounding should be labeled as close as practicable (i.e. for ease of access and to read the label) to the point of termination.
- B. Labels shall be non-metallic and include the following:



3.9 PATHWAY IDENTIFICATIONS:

- A. Conduits:
  - 1. Label each conduit used for communications at each end with a computer-generated label indicating the conduit number and far-end destination. This condition includes within underground vaults, handholes and boxes as well as the point where conduits enter a building.
  - 2. Label lettering shall be 1/2-inch tall for conduits larger than 2 inches.
- B. Wireways:
  - 1. Label each wireway used for communications at each end with a 1-1/2 inches by 3 inches weatherproof phenolic label indicating the wireway number and usage.
  - 2. Label lettering to be 1/2-inch tall and white on black background.
  - 3. Affix label with adhesive. Use of screws or penetration of the wireway is prohibited.
- C. Cable and basket trays:
  - 1. Label each cable tray used for communications every 50 feet with a 1-1/2 inch by 3 inch phenolic label indicating the wireway number and usage (i.e. – BACKBONE COMMUNICATION CABLING).



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2. Label lettering to be 1/2-inch tall and black on orange background.
3. Affix label with cable ties or other approved use. Use of screws or metal penetrating into the wiring area is prohibited.
4. Provide larger label if required to accommodate text.
5. Submit samples for approval by A/E before installation.

**END OF SECTION 27 05 53**



## **SECTION 27 11 16 - COMMUNICATIONS RACKS, CABINETS, AND ENCLOSURES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Cabinets, racks, enclosures and mounting frames for communication equipment and terminations in Communications Rooms and spaces.

#### **1.2 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to Section 27 00 00 "Communications" which identifies related specification sections in this and other Divisions (if applicable). Where modified, the modification will supersede the original condition.
- C. Related Work Specified Elsewhere:
  - 1. Section 01 33 00 Submittal Procedures
  - 2. Section 27 05 28 Pathways for Communication Systems
  - 3. Section 27 05 53 Labeling for Communication Systems
  - 4. Section 27 11 19 Copper Patch Panels and Wiring Blocks
  - 5. Section 27 11 23 Communications Cable Management and Ladder Rack
  - 6. Section 27 13 13 Communications Copper Backbone Cabling
  - 7. Section 27 13 23 Communications Optical Fiber Backbone Cabling
  - 8. Section 27 15 13 Communications Copper Horizontal Cabling
  - 9. Section 27 16 19 Communications Patch Cords, Station Cords, and Cross Connect Wire

#### **1.3 REFERENCES**

- A. All documents referenced in Section 27 00 10 General Provisions for Communication Systems are hereby incorporated by reference within this Section.
  - 1. Emphasis shall be placed on articles specifying grounding/earthing standards, cabling and cabling management standards and procedures.

#### **1.4 REGULATORY REQUIREMENTS**

- A. All Work shall conform to the requirements of NFPA 70.



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- B. All Work shall conform to the requirements of all Federal, State and Local Electrical and Telecommunications Regulations.

1.5 DESCRIPTION AND GENERAL SPECIFICATIONS

- A. Provide all labor, materials, tools, equipment and services required to complete the work described herein and shown on the drawings and as required to provide a fully operational system.
- B. All equipment shall be UL listed and suitable for the environment it is installed.
- C. The drawings, which constitute a part of these specifications, indicate locations where cabinets, racks and other enclosures are to be placed. Where indicated and dimensioned, equipment shall be placed in the specified location. Where not dimensioned, such equipment shall be mounted in the configuration and order shown and as close to the indicated location as practical. Where not shown, or where unclear or in conflict with other work, the Contractor shall verify exact location with Owner's Representative before proceeding with work.
- D. Contractor shall verify existing field conditions and coordinate exact locations, distances and levels with other work of this Section and with other trades prior to installation. Notify the Designer or Owner's Representative of any changes due to conflicts with other trades work, or due to any other reason other than of a minor nature prior to proceeding with work.
- E. Make necessary provisions for storage of materials and equipment at the site to ensure the quality and condition of the product to be installed. Use only materials and products that are new, free of defect, and which arrive unopened and in the original container at the jobsite.
- F. Notify the Owner's Representative at least two (2) full working days prior to covering of concealed communications work.

1.6 WORK BY OWNER

- A. Refer to Section 27 00 00 "Communications" which identifies Work by the Owner affecting the sub-system(s) covered by this section.

1.7 DEFINITIONS

- A. Refer to Section 27 00 00 "Communications" which provides information on Definitions and Abbreviations used in this and related sections.
- B. BICSI: Building Industry Consulting Service International.
- C. LAN: Local area network.



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- D. RCDD: Registered Communications Distribution Designer.
- E. The term "Telecommunication Room", as used in this Section, means all rooms containing telecommunication cabling, equipment racks and cabinets, cross connect and termination panels and blocks, and/or electronic telecommunication equipment. Included are Telecommunication Entrance Rooms, Equipment Rooms, MDFs, IDF's, and Telecommunication Closets/Rooms. Also included are Computer Rooms and dedicated Server Rooms.

NOTE: This term differs slightly from the term "telecommunication spaces" in that "spaces" also includes work areas, vaults, etc in addition to the areas mentioned above. It also differs slightly from the term recently adopted to replace the term "telecommunication closets" as it is more expansive. It is used to identify the above areas for the purpose of this section. Where the retired term "Telecommunication Closet" is meant in this Specification, it shall be so used to denote the cross connect area for horizontal cabling.

## 1.8 ABBREVIATIONS AND ACRONYMS

- A. See specification 27 00 10 General Provisions for Communication Systems Section 1.8 Abbreviations and Acronyms.

## 1.9 SUBMITTALS

- A. Refer to Section 27 00 00 "Communications" which provides general guidelines for product and/or installation information to be submitted by the contractor.
- B. Manufacturer's Catalog Data shall be submitted for the following items at minimum:
  - 1. Equipment racks and associated hardware.
  - 2. Distribution frames and associated hardware.
  - 3. Equipment cabinets and associated hardware, including fan and ventilation units and integral power strips and cable management.
  - 4. Other interior enclosures.
  - 5. Exterior enclosures, including self-standing temporary and permanent sheds and pad mounted housings.
- C. Data shall include a complete list of parts, special tools, and supplies with source of supply.
- D. Provide the number of copies of submittals required under the general provisions of these specifications. Submittals shall consist of neatly bound copies of catalog cuts, data sheets, manufacturers' installation recommendations, and other descriptive information, for all specified materials, assembled in accordance with the requirements of Section 16010.



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- E. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
  - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
- F. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- G. Seismic Qualification Certificates: For equipment frames from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.10 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 "Communications" which identifies general quality assurance requirements for the project.
- B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  - 1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
  - 2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
  - 3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.



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## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Where not indicated or specified otherwise, free-standing racks and cabinets shall be rated for a minimum of 1,000 lbs.
- B. All racks and cabinets shall be UL-listed.

### 2.2 RACKS AND ENCLOSURES

- A. 19" 2 Post equipment racks
  - 1. Type: 19" x 7'0" universal open-relay type equipment rack
  - 2. EIA channels: 3" x 1.265" x 1/4" thick flange
  - 3. Base Angles: 3-1/2" x 6" x 3/8" thick (pair)
  - 4. Top Angles: 1-1/2" x 1-1/2" x 1/4" thick (pair)
  - 5. Panel Mounting Holes: #12-24 rolled thread in both channel flanges
  - 6. Hole pattern: EIA Universal 5/8" x 5/8" x 1/2"
  - 7. Mounting screws: Black, #12-24 with combination Phillips/Straight heads – include quantity 50 and deliver to customer
  - 8. Finish: Black
  - 9. Approved Manufacturer: Chatsworth Products
    - a. Type: 19" x 7'0" universal open-relay type equipment rack, black, Part #48353-703

### 2.3 CABINETS

- A. Wall Mounted Cabinet Cube-It
  - 1. Size 36"H X 24"D X 24"W
  - 2. Three part swing out design
  - 3. Single lock/key front door
  - 4. Square punched adjustable equipment mounting rails
  - 5. Rear Panel knock outs for 3/4", 1" and 2.5" conduits
  - 6. Rear Panel cable slack management
  - 7. Approve Manufacture: Chatsworth Products
    - a. Cabinet CPI Part# 11840-736
    - b. Bottom CPI Part# 11966-736
    - c. Dual Fan/Air Filter CPI Part# 40975-001
    - d. Vertical Cable Section Kit CPI Part# 40975-0001
    - e. Cable Port Brush Kit CPI Part# 25190-000
    - f. 19RU Equipment Mount Rail Kit CPI Part# 12787-536



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B. Floor Mount Cabinet ZetaFrame

1. Size 29.5in (750mm) W X 41.3in (1050mm)D X 45RMU
2. Color: Black
3. Floor Leveling Kit
4. (2) Square Punch Rails
5. (4) Grommet-Sealed Cable Openings
6. Cable Openings
7. Perforated Metal Door
8. Double Perforated Door
9. Solid Side Panels
10. 3 Point Keylock
11. Top Panel with 4 Brushed Sealed Openings
12. 2 Piece PDU Bracket Kit
13. Approved Manufacture: Chatsworth Products
  - a. CPI Part Number ZB33-A2200-7

2.4 HORIZONTAL AND VERTICAL WIRE MANAGEMENT

A. Vertical Cable Manager, 6" X 108" X 9.7" Deep Double Sided w/door, Black.

1. Approved Manufacturer: Chatsworth Products
  - a. 6" CPI Part #35571-703

B. Horizontal Cable Manager 2RU w/door, Black.

1. Approved Manufacturer: Chatsworth Products
  - a. Horizontal Wire Manager 2U CPI Part #35441-702

C. UPS

1. Uninterruptable Power Supply (UPS)
  - a. For each IT rack and the Audio-Visual Cabinet Furnish and install 1 UPS per location as detailed in the Bid documents
    - 1) UPS to be 5KW in size (confirm load requirements prior to purchase)
    - 2) Rack mountable
    - 3) Provide 15 minutes of uptime
    - 4) With a minimum of 2 L6-30's,
    - 5) Preferred Manufacturer – APC
  - b. Confirm UPS model and connection requirements with client IT group prior to purchase.
2. Power Strips: Comply with UL1363.
  - a. Number of Outlets and configuration to be confirmed with the Owner prior to purchase
3. Acceptable manufacturers
  - a. APC



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- b. Chatsworth
- c. Server Tech
- d. Tripp Lite

2.5

2.6 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional TDS installation shall be provided in a level of quality consistent with other specified items.

2.7 GROUNDING

- A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Telecommunications Main Bus Bar:
  - 1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
  - 2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
  - 3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
- C. Comply with TIA-607-C.

2.8 LABELING

- A. Comply with TIA/EIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
  - 1. Preferred Manufacturer: Brady

2.9 FIRESTOPPING

- A. Refer to Division 07 84 13 "Penetration Firestopping."
- B. Comply with BICSI TDMM, "Firestopping Systems" Article.



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PART 3 - EXECUTION

3.1 GENERAL

- A. Ensure anti-static flooring type has been installed prior to installation of all equipment racks and/or cabinets.
- B. Prior to any drilling in the slab or raised floor, ensure area is free of obstructions.
- C. If drilling into the floor slab is required, confirm floor slab composition. If floor slab is composed of rebar or tension cables within the slab, contractor to X-Ray floor prior to any drilling to alleviate any possible obstructions.

3.2 EQUIPMENT RACKS AND CABINETS

- A. All equipment and hardware in telecommunication spaces (telecom rooms, closets, equipment rooms, entrance facilities, etc.) shall be installed in a neat and workmanlike manner.
- B. Assemble relay racks according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.
- C. All equipment and hardware shall be fastened with bolts and approved hardware and made solid and secure. Racks must be attached to the floor in four places using appropriate floor mounting anchors.
- D. When placed over a raised floor, threaded rods shall pass through the raised floor tile and be secured in the structural floor below. (Use CPI Part Number 40604-003 for concrete slab floors or 40607-001 wood floors. Raised floor support kits are also available.)
- E. In all cases where freestanding racks and cabinets are installed, install minimum 12" ladder racking from the rack or cabinet to the wall behind the rack or cabinet. Secure with mounting plates and wall angles.
- F. Securely bolt each rack to the structural floor and bolt all adjacent racks to each other.
- G. For IDF row provide securely mount HAC containment per manufacturer's recommendations.
- H. Provide and install (1) vertical cable manager for each equipment rack. Where more than 1 rack is installed and connected together, provide and install vertical cable management between each rack and on each end of the rack row.



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3.3 SEISMIC CONSIDERATIONS

- A. Equipment racks and cabinets, frames and enclosures shall be seismically braced in accordance with requirements for seismic Zone 4. Seismic bracing shall consist of rigid supports. Cables, wires, chains or other non-rigid materials shall not be used for seismic support. Provide approved fixed equipment anchorage assemblies as published by the manufacturer. In lieu of manufacturer's published seismic bracing assemblies, the Contractor shall provide seismic installations approved by a licensed structural engineer.
- B. Approved drawings of seismic assemblies shall be made available for review by the Contracting Agency or the inspecting Authority Having Jurisdiction upon request.

3.4 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
  - 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
  - 2. Record agreements reached in meetings and distribute them to other participants.
  - 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
  - 4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.5 FIRESTOPPING

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."



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- B. Comply with requirements in Section 27 05 37 "Firestopping for Communications Systems."
- C. Comply with TIA-569-D, Annex A, "Firestopping."
- D. Comply with BICSI TDMM, "Firestopping Systems" Article.

### 3.6 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-C.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
  - 1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

### 3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
- B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Comply with requirements in section 27 05 53 "Identification for Communications Systems."
- D. Labels shall be preprinted or computer-printed type.

### 3.8 HOUSEKEEPING PADS

- A. Provide housekeeping pads under all racks and equipment located outdoors or where subject to damage from water or other liquids.

**END OF SECTION 27 11 16**



## **SECTION 27 11 19 - COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS**

### **PART 1 - GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Termination Blocks and Patch Panels.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

#### **1.2 SUBMITTALS**

- A. Provide product data from manufacturer's specifications.

#### **1.3 WORK INCLUDED**

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.
- B. The work shall include, but not be limited to the following:
  - 1. Furnish and install all patch panels.
  - 2. Furnish and install all optical fiber panels/enclosures.

### **PART 2 - PRODUCTS**

#### **2.1 APPROVED PRODUCTS**

- A. Approved Patch Panel Manufacturer(s)
  - 1. Leviton
  - 2. Panduit
  - 3. CommScope



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B. Approved Optical Fiber Enclosure Manufacturer(s)

1. Leviton
2. Panduit
3. CommScope

2.2 PATCH PANELS

A. Category 6 Patch Panel

1. The Category 6 patch panel shall be compatible with 19" equipment racks, cabinets, or wall mount brackets.
2. The Category 6 patch panel shall be equipped with 8-position modular ports and shall allow for termination using both T568A and T568B wiring schemes.
3. The Category 6 patch panel shall be equipped with front labeling space to facilitate port identification.
4. The Category 6 patch panel shall be Power Sum rated, with a Power Sum NEXT performance equal to or better than ANSI/TIA/EIA-568-B.2.1 Category 6 pair-to-pair NEXT performance specifications.
5. Approved Manufacturers: Leviton or Equal
  - a. Cat 6 Universal Patch Panel, 48-Port, 2RU, black, Part #69586-U48
  - b. Equivalent Manufacturers
    - 1) Panduit
    - 2) CommScope

B. Category 6A Patch Panel

1. The Category 6A patch panel shall be compatible with 19" equipment racks, cabinets, or wall mount brackets.
2. The Category 6A patch panel shall be equipped with 8-position modular ports and shall allow for termination using both T568A and T568B wiring schemes.
3. The Category 6A patch panel shall be equipped with front labeling space to facilitate port identification.
4. The Category 6A patch panel shall be Power Sum rated, with a Power Sum NEXT performance equal to or better than ANSI/TIA/EIA-568-B.2.1 Category 6A pair-to-pair NEXT performance specifications.
5. Approved Manufacturers: Leviton or Equal
  - a. Cat 6A Flat Patch Panel, 110-style meets TIA 19 in Rack Mount, 48-Port configured, Part #6A586-U48
  - b. Equivalent Manufacturers
    - 1) Panduit
    - 2) CommScope



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2.3 OPTICAL FIBER PANELS/ENCLOSURES

A. Rack Mount Optical Fiber Panel/Enclosure

1. The rack mount optical fiber panel/enclosure shall be equipped with either a swing out mechanism or a sliding drawer to access fibers.
2. The rack mount optical fiber panel/enclosure shall be capable of terminating tight-buffered or loose tube optical fiber cables and all popular connector types.
3. The rack mount optical fiber panel/enclosure shall provide for bend radius control throughout the panel as well as storage space for slack cabling.
4. Approved Manufacturer: Leviton or Equal
  - a. 1000i SDX 4RU Distribution and Splice Enclosure, empty, Part #5R4UM-F15
  - b. Opt-X 1000i SDX 1RU Distribution and Splice Enclosure, Part #5R1UM-S03
  - c. Equivalent Manufacturers
    - 1) Panduit
    - 2) CommScope
5. The rack mount optical fiber panel/enclosure shall be equipped with optical fiber adapter panels.
  - a. The optical fiber adapter panels shall be offered in two types of sleeve material: phosphor bronze and ceramic.
  - b. The optical fiber adapter panels shall accommodate either multimode or singlemode terminated optical fiber.
  - c. The optical fiber adapter panels shall be pre-loaded with up to 12 adapters.
  - d. The optical fiber adapter panels shall be compatible with LC connectors.
6. Approved Manufacturer: Leviton or Equal
  - a. SDX Pigtail Fusion Splice Module pre-loaded with quad LC adapters (Blue) and 24-fiber OS2 LC/UPC individual pigtails, Part #SPLCS-24L
  - b. Equivalent Manufacturers
    - 1) Panduit
    - 2) CommScope

PART 3 - EXECUTION

3.1 PATCH PANELS

- A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B standard, manufacturer's recommendations and best industry practice.
- B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).



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- C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- D. Cables shall be neatly bundled and dressed to their respective patch panel. Each patch panel shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- E. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

### 3.2 OPTICAL FIBER PANELS/ENCLOSURES

- A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B.3 document, manufacturer's recommendations and best industry practices.
- B. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
- C. Bend radius of the optic fiber cable in the panel/enclosure shall not exceed 10 times the outside diameter of the cable.
- D. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
- E. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.
- F. A maximum of 12 strands of fiber shall be spliced in each tray
- G. All spare strands shall be installed into spare splice trays.
- H. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.



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3.3 IDENTIFICATION

- A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

**END OF SECTION 27 11 19**



## **SECTION 27 11 23 - COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK**

### **PART 1 - GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Cable Management and Ladder Rack.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

#### **1.2 SUBMITTALS**

- A. Provide product data from manufacturer's specifications.

#### **1.3 WORK INCLUDED**

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.
- B. The work shall include, but not be limited to the following:
  - 1. Furnish and install all horizontal cable management.
  - 2. Furnish and install all vertical cable management.
  - 3. Furnish and install ladder rack system.
  - 4. Furnish and install all tie wraps/Velcro straps.
  - 5. Furnish and install all C-rings/D-rings.

### **PART 2 - PRODUCTS**

#### **2.1 APPROVED PRODUCTS**

- A. Approved Horizontal Cable Management Manufacturer(s)
  - 1. Chatsworth Products



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- a. CPI Part #35441-702
- B. Approved Vertical Cable Management Manufacturer(s)
  - 1. Chatsworth Products
    - a. CPI Part #35571-703
- C. Approved Ladder Rack System Manufacturer(s)
  - 1. Chatsworth Products
    - a. CPI Part #10750-716
- D. Approved Cable Runway Radius Drop Manufacturer(s)
  - 1. Chatsworth Products
    - a. CPI Part #12100-718
- E. Approved Elevation Runway Kit 3" Manufacturer(s)
  - 1. Chatsworth Products
    - a. CPI Part #10506-706
- F. Approved Wall Angle Kit Manufacturer(s)
  - 1. Chatsworth Products
    - a. CPI Part #11421-718
- G. Approved Triangle Support Bracket Manufacturer(s)
  - 1. Chatsworth Products
    - a. CPI Part #11746-718
- H. Approved Butt Splice Kit Manufacturer(s)
  - 1. Chatsworth Products
    - a. CPI Part #11301-701
- I. Approved Tie Wrap/Velcro Strap Manufacturer(s)
  - 1. Velcro
  - 2. Or Approved Equal
- J. Approved C-Ring/D-ring Manufacturer(s)
  - 1. Leviton
  - 2. Or Approved Equal



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## 2.2 CABLE MANAGEMENT - HORIZONTAL

### A. Horizontal Cable Management

1. The horizontal wire manager shall be compatible with 19-inch equipment racks, cabinets or wall mount brackets.
2. The horizontal cable manager shall provide support for patch cords at the front of the panel.
3. The horizontal cable manager shall be 2 rack-units in height and color shall be black.

## 2.3 CABLE MANAGEMENT - VERTICAL

### A. Vertical Cable Management

1. The vertical cable manger shall be double-sided w/doors.
2. The vertical cable manager shall provide support for patch cords at the front of the rack and wire management at the rear of the rack.
3. The vertical cable manager shall be a minimum width of 6" and/or 12".
4. Vertical cable manager color shall be black.

## 2.4 LADDER RACKS

### A. Ladder Rack System

1. See Drawings for ladder rack system details.
2. The ladder rack system shall be securely mounted with hardware designed for use in ladder rack systems.
3. End caps shall be installed on the exposed ends of the ladder racks, channel supports and bolts. Protective covers shall be installed on threaded rods that come in contact with cabling plant.
4. Ladder Rack System color shall be black.

## 2.5 TIE WRAPS AND VELCRO STRAPS

### A. Tie Wraps and Velcro Straps

1. Backbone cables shall be fastened to support structures with tie wraps/Velcro straps.
2. Horizontal cables shall be fastened to support structures with Velcro straps.
  - a. Tie Wrap color shall be black.
  - b. Velcro Strap color shall be black.



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2.6 C-RINGS/D-RINGS

A. C-Rings/D-rings

1. C-rings/D-rings shall be used on backboards to support cables, patch cords and cross-connect wire.
2. C-rings/D-rings shall be made of high-strength, fire-retardant material with rounded edges to prevent damage to cable and wire insulation.

PART 3 - EXECUTION

3.1 CABLE MANAGEMENT - HORIZONTAL

- A. Horizontal cable managers shall be installed below patch panels in a 1:1 ratio (one horizontal cable manager per patch panel) or as indicated on Drawings.

3.2 CABLE MANAGEMENT - VERTICAL

- A. Vertical cable managers shall be installed on both sides of a single equipment rack. Where two (2) or more racks are positioned in a row, vertical cable managers shall be installed between each rack and each end of the row.

3.3 LADDER RACKS

- A. Ladder rack system shall be installed straight, level and perpendicular to walls and ceiling slabs.
- B. Ladder racks shall be supported at 5' intervals maximum.
- C. Provide all hardware, accessories, fasteners, anchors, threaded rods and support channels required to provide a complete ladder rack system.
1. Provide Radius Drops from ladder rack to equipment racks and cabinets
- D. See Drawings for ladder rack system details.

3.4 TIE WRAPS AND VELCRO STRAPS

- A. Tie wraps/Velcro straps shall be installed around cables at intervals of 12" minimum.
- B. Tie wraps shall secure cables to ladder racks using an "X" pattern.
- C. Do not over-cinch cables.



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3.5 C-RINGS/D-RINGS

- A. C-ring/D-rings shall be installed on 3/4" backboard, straight and level.

3.6 IDENTIFICATION

- A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

**END OF SECTION 27 11 23**



## **SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING**

### **PART 1 - GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Optical Fiber Backbone Cabling.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

#### **1.2 SUBMITTALS**

- A. Provide product data from manufacturer's specifications.

#### **1.3 WORK INCLUDED**

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.
- B. The work shall include, but not be limited to the following:
  - 1. Furnish and install all optical fiber backbone cable (inside plant).
  - 2. Furnish and install optical fiber backbone cable (outside plant).
  - 3. Furnish and install all optical fiber connectors.
  - 4. Perform all optical fiber splices.
  - 5. Furnish and install all splice cases.

### **PART 2 - PRODUCTS**

#### **2.1 APPROVED PRODUCTS**

- A. Approved Optical Fiber Backbone Cable (Inside Plant) Manufacturer(s) or equal
  - 1. Leviton



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- a. Single Mode – Bend Insensitive OS2 Tight Buffered, Part #AB0707
    - b. Equivalent Manufacturers
      - 1) Panduit
      - 2) Corning
      - 3) CommScope
  - B. Approved Optical Fiber Backbone Cable (Outside Plant) Manufacturer(s) or equal
    - 1. Leviton
      - a. Single-Mode Bend Insensitive, Loose Tube, OSP, OS2, Part #AB0403
      - b. Equivalent Manufacturers
        - 1) Panduit
        - 2) CommScope
        - 3) Corning
  - C. Approved Optical Fiber Connectivity Manufacturer(s)
    - 1. Leviton
  - D. Approved Splice Case Manufacturer(s)
    - 1. Leviton
    - 2. Corning
    - 3. Or approved equal
- 2.2 OPTICAL FIBER BACKBONE CABLE (INSIDE PLANT)
- A. Plenum - Indoor Distribution 50/125 Multimode Optical Fiber Non-Conductive (OFNP) Tight Buffered Cable
    - 1. Generic Characteristics
      - a. The indoor optical fiber cable shall be available with up to twelve 900-micron tight-buffered 250-micron fibers placed in a color-coded sub-unit bundle with aramid strength elements.
      - b. The indoor optical fiber cable shall have sequential length marking printed on the cable jacket.
      - c. Maximum attenuation dB/Km @ 850/1300 nm: 3.5/1.5
      - d. Bandwidth 500 MHz-km @ 850 nm.
      - e. Bandwidth 500 MHz-km @ 1300 nm.
  - B. Plenum - Indoor Distribution 8.3/125-micron Singlemode Optical Fiber Non-Conductive (OFNP) Tight Buffered Cable
    - 1. Generic Characteristics
      - a. The indoor optical fiber cable shall be available with up to twelve 900-micron tight-buffered, 250-micron fibers placed in a color-coded sub-unit bundle with aramid strength elements.



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- b. The indoor optical fiber cable shall have sequential length markings printed on the cable jacket.
  - c. All singlemode fibers shall be pigtail spliced into a rack mounted optical fiber enclosure or wall-mounted enclosure.
  - d. The loss of fiber shall not exceed 1.0 dB per kilometer @ 1550 nm and 1.0 dB per kilometer @ 1310 nm.
- C. Riser - Indoor/outdoor 50/125 Multimode Optical Fiber Non-Conductive (OFNR) Loose Tube cable
  - 1. Generic Characteristics
    - a. The indoor/outdoor optical fiber cable with up to twelve 250-micron coated fibers placed in a color-coded sub-unit bundle with moisture-blocking gel.
    - b. The indoor/outdoor optical fiber cable shall have sequential length markings printed on the cable jacket.
    - c. Maximum attenuation dB/Km @ 850/1300 nm: 3.5/1.5
    - d. Bandwidth 160 MHz-km @ 850 nm.
    - e. Bandwidth 500 MHz-km @ 1300 nm.
- D. Riser - Indoor/outdoor 8.3/125-micron, Singlemode Optical Fiber Non-Conductive (OFNR) Loose Tube cable
  - 1. Generic Characteristics
    - a. The indoor/outdoor optical fiber cable with up to twelve 250-micron coated fibers placed in a color-coded sub-unit bundle with moisture-blocking gel.
    - b. The indoor/outdoor optical fiber cable shall have sequential length markings printed on the cable jacket.
    - c. All singlemode fibers shall be pigtail spliced into a rack mounted optical fiber panel or wall-mounted enclosure.
    - d. The loss of fiber shall not exceed 0.50 dB per kilometer @ 1550 nm and 0.50 dB per kilometer @ 1310 nm.

## 2.3 OPTICAL FIBER BACKBONE CABLE (OUTSIDE PLANT)

- A. Indoor/outdoor 50/125 Multimode Optical Fiber Non-Conductive (OFNR) Loose Tube cable
  - 1. Generic Characteristics
    - a. The indoor/outdoor optical fiber cable with up to twelve 250-micron coated fibers placed in a color-coded sub-unit bundle with moisture-blocking gel.
    - b. The indoor/outdoor optical fiber cable shall have sequential length markings printed on the cable jacket.
    - c. Maximum attenuation dB/Km @ 850/1300 nm: 3.5/1.5
    - d. Bandwidth 500 MHz-km @ 850 nm.
    - e. Bandwidth 500 MHz-km @ 1300 nm.
- B. Indoor/outdoor 8.3/125-micron, Singlemode Optical Fiber Non-Conductive (OFNR) Loose Tube cable



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1. Generic Characteristics
  - a. The indoor/outdoor optical fiber cable with up to twelve 250-micron coated fibers placed in a color-coded sub-unit bundle with moisture-blocking gel.
  - b. The indoor/outdoor optical fiber cable shall have sequential length markings printed on the cable jacket.
  - c. All singlemode fibers shall be pigtail spliced into a rack mounted optical fiber enclosure or wall-mounted enclosure.
  - d. The loss of fiber shall not exceed 0.50 dB per kilometer @ 1550 nm and 0.50 dB per kilometer @ 1310 nm.

## 2.4 OPTICAL FIBER CONNECTORS

### A. Multimode Fiber Connectivity

1. The optical fiber field-installable connector shall be LC format, for installation onto either multimode 50/125-micron fiber.
2. The optical fiber field-installable connector shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.
3. The optical fiber field-installable connector shall have a maximum Loss of .5 dB.
4. The optical fiber field-installable connector shall have a typical Reflectance of -30 dB.

### B. Singlemode Fiber Connectivity

1. The optical fiber field-installable connector shall be LC format, for installation onto singlemode 8.3/125-micron fiber.
2. The optical fiber field-installable connector shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.
3. The preferred method of terminating loose-tube singlemode fiber is pigtail splicing into a rack mounted optical fiber panel or wall-mounted enclosure. Pigtails shall be factory terminated and 3 meters in length. A fiber enclosure with slack storage trays must be used when pigtail-splicing method is used.
4. The splice loss through each connector pair shall not exceed 0.50 dB.
5. All singlemode connectors (pigtails and field terminated) shall be SC.

## 2.5 SPLICE CASES

### A. Canister Splice Case

1. Splice cases shall be water tight and designed for outside plant applications.
2. All splice trays, seals and hardware shall be from the same manufacturer as the splice case.
3. Splice trays shall utilize heat-shrink seals.
4. See Drawings for size requirements.



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PART 3 - EXECUTION

3.1 BACKBONE CABLES (INSIDE PLANT)

- A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B.2 document, manufacturer's recommendations, and best industry practices.
- B. Backbone cables shall be installed separately from horizontal distribution cables
- C. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
- D. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits
- E. Exposed cables must be CMP or MMP rated if installed in an air return plenum. Riser rated cables shall be installed in metallic conduit if installed in an air return plenum.
- F. Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
- G. Leave 10' of slack on each end of fiber backbone cable.
- H. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.
- I. Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.
- J. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.
- K. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- L. Each optical fiber cable shall be individually attached to the respective enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
- M. Each optical fiber cable shall be clearly labeled at the entrance to the enclosure. Cables labeled within the bundle shall not be acceptable.
- N. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.



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- O. A maximum of 12 strands of fiber shall be spliced in each tray
- P. All spare fiber strands shall be installed into spare splice trays.
- Q. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

3.2 BACKBONE CABLES (OUTSIDE PLANT)

- A. All OSP cables brought to the Entrance Facilities shall have 15 ft of slack coiled and secured to the wall in the proximity of the fiber enclosure.
- B. All cables shall be tagged and identified within each handhole/maintenance hole.
- C. Place initial cables in bottom conduits to facilitate easy subsequent cable placement.
- D. Place leader guard in the duct before placing cable to prevent damaging the cable sheath on the sharp edge of the duct.
- E. Ventilate maintenance where gas has been detected before entering the maintenance hole.
- F. To ensure that the optical fiber cable's qualities and characteristics are not degraded during installation, excessive pulling tensions and short bending radii will not be allowed. The maximum pulling tension is 600 lbs. The minimum bending radius for cable under tension is 20 times the outside diameter of the cable and for cable at rest is 10 times the outside diameter of the cable.
- G. A 600 lb. break-away swivel, along with a slip clutch capstan winch that shows the dynamometer (pulling tension) reading, shall be used at all times during pulling.
- H. At each splice location the cable ends will be sealed watertight at all times. Reels will be continuously manned during cable installation.
- I. Contractor shall coil 60 feet of spare optical fiber cable in each handhole/maintenance hole without a splice and 75 feet of each optical fiber cable in each handhole/maintenance hole with a splice. Cable coils shall have at least two points of support on the optical fiber racking system.
- J. When mounting the optical fiber slack coils, the minimum bend radius shall not be exceeded; this radius is equal to 10 times the outside diameter of the cable in a static application and 20 times the outside diameter in a dynamic application. At anytime during the entire handling process of the optical fiber cable, as much care as possible should be maintained and all the manufacturer's recommendations should be followed.



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3.3 OPTICAL FIBER CONNECTIVITY / SPLICING

- A. Optical fiber connectors shall be installed as per the requirements specified by the manufacturer's installation guidelines.
- B. All splicing shall be of the fusion type made under Light Injection and Detection Mode, whenever applicable. The Contractor shall provide certified and experienced personnel for splicing.
- C. Contractor's tools and equipment shall be in excellent working order. Any worn or improperly working tools shall be discarded and not used on this project. All fusion splicers shall be calibrated and labeled according to the manufacturer's specifications. Contractor shall submit certification of calibration for the fusion splicers to the Engineer.

3.4 SPLICE CASES

- A. Splice Cases shall be installed as per the requirements specified by the manufacturer's installation guidelines.

3.5 IDENTIFICATION

- A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

**END OF SECTION 27 13 23**



## **SECTION 27 15 13 - COMMUNICATIONS COPPER HORIZONTAL CABLING**

### **PART 1 - GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Copper Horizontal Cabling.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

#### **1.2 SUBMITTALS**

- A. Provide product data from manufacturer's specifications.

#### **1.3 WORK INCLUDED**

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.
- B. The work shall include, but not be limited to the following:
  - 1. Furnish and install all horizontal copper cable.

### **PART 2 - PRODUCTS**

#### **2.1 APPROVED PRODUCTS**

- A. Approved Horizontal Copper Cable Manufacturer(s)
  - 1. Uniprise (CommScope)
  - 2. Berk-Tek
  - 3. Panduit



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2.2 HORIZONTAL COPPER CABLE

- A. Telecommunications Outlets: 100 OHM Category 6/Class E, Balanced Twisted Pair Cable, 23 AWG
1. The horizontal balanced twisted pair cable shall provide positive PSACR up to 250 MHz.
  2. The horizontal balanced twisted pair cable shall meet or exceed the Category 6 transmission characteristics per issue of ANSI/TIA-568-D.
  3. Cable jacket shall be FEP Plenum CMP rated.
  4. All four pair pairs shall be surrounded by aluminum/polyester tape and jacketed with flame-retardant polymer alloy.
  5. Jacket color shall be:
    - a. Blue for voice/data unless used for outdoor applications.
  6. Manufacturer: Berk-Tek or Equal
    - a. LANmark-6 UTP, plenum, blue, Part # 10136226
    - b. Indoor/Outdoor rated, plenum, black, Part # 11101514
- B. Wireless Access Points: 100 OHM Category 6A/Class EA, Balanced Twisted Pair Cable, 23 AWG
1. The horizontal balanced twisted pair cable shall provide positive PSACR up to 500 MHz
  2. The horizontal balanced twisted pair cable shall meet or exceed the Category 6A transmission characteristics per issue of ANSI/TIA-568-D.
  3. Cable jacket shall be FEP Plenum CMP rated.
  4. All four pair pairs shall be surrounded by aluminum/polyester tape and jacketed with flame-retardant polymer alloy.
  5. Jacket color shall be:
    - a. Blue for voice/data unless used for outdoor applications.
  6. Manufacturer: Berk-Tek or Equal
    - a. LANmark-10G2 Cat 6A, U/UTP, plenum, blue, Part # 10130484
    - b. Indoor/Outdoor rated, plenum, black, Part # 11101959
    - c. Equivalent manufacturers
      - 1) CommScope Uniprise
      - 2) Panduit/General

PART 3 - EXECUTION

3.1 HORIZONTAL CABLES

- A. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.



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- B. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit. A new fresh pull string shall be installed after final cable installation.
- C. Cable raceways shall not be filled greater than the ANSI/TIA-569-D maximum fill for the particular raceway type.
- D. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
- E. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.
- F. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- G. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60-inch intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- H. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.
- I. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- J. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers to support the cabling.
- K. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.
- L. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA-568-D document, manufacturer's recommendations, and best industry practices.
- M. Leave a minimum of 6" of slack for twisted pair cables at the TO, behind faceplate after termination. Cables shall be coiled in the in-wall box, surface-mount box or modular furniture raceway if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. In hollow-wall installations where box-eliminators are used, excess cable can be stored in the wall.
- N. Contractor shall provide a service loop at both ends of each cable run.



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1. Stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
  2. The service loop at each location in the ceiling shall be 10' at each TO location. Install within 18" of TO serving conduit.
  3. Provide 10' service loop at the TR side.
  4. Contractor shall ensure no cables exceed the 295' length for a permanent link.
- O. Cables shall be neatly bundled and dressed to their respective termination device. Each terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- P. Each cable shall be clearly labeled on the cable jacket behind the termination device at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

### 3.2 IDENTIFICATION

- A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

### 3.3 WARRANTY

- A. Contractor shall certify and provide a system that offers a manufacturer's warranty no less than 25-years and applications assurance as a registered channel solution.
- B. Current manufacturer certifications shall be valid at the time of installation. Provide verified certificates from manufacturer at time of bidding.

**END OF SECTION 27 15 13**



## **SECTION 27 15 43 - COMMUNICATIONS FACEPLATES AND CONNECTORS**

### **PART 1 - GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Faceplates and Connectors.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

#### **1.2 SUBMITTALS**

- A. Provide product data from manufacturer's specifications.

#### **1.3 WORK INCLUDED**

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.
- B. The work shall include, but not be limited to the following:
  - 1. Furnish and install all copper connectivity.
  - 2. Furnish and install all faceplates.
  - 3. Furnish and install all surface mount boxes.

### **PART 2 - PRODUCTS**

#### **2.1 APPROVED PRODUCTS**

- A. Approved Copper Connectivity Manufacturer(s)
  - 1. Leviton
  - 2. Panduit
  - 3. Uniprise (CommScope)



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B. Approved Faceplate Manufacturer(s)

1. Leviton
2. Panduit
3. Uniprise (CommScope)

C. Approved Surface Mount Box manufacturer(s)

1. Leviton
2. Panduit
3. Uniprise (CommScope)

2.2 COPPER CONNECTIVITY

1. Telecommunications Outlets: Category 6, RJ45, 8-Position, 8-Contact (8P8C), 10 Gb/s, universal module
  - a. The connector module shall be Power Sum rated, with a Power Sum NEXT performance equal to or better than the ANSI/TIA/EIA-568-B.2.1 Category 6, pair to-pair NEXT performance specifications.
  - b. The eight-position connector module shall accommodate six-position modular plug modular cords without damage to either the cord or the module.
  - c. The connector module shall be designed for use at the work area (WA), communications room (TR) and/or equipment room (ER) without modification.
  - d. The connector module shall be available in both the T568A and T568B wiring configurations within the same module.
  - e. The connector module shall have an insulation displacement connection featuring insulation slicing of 22 to 24 AWG plastic-insulated solid copper conductors forming a gas-tight connection.
  - f. Icons shall be used if offered from the manufacturer.
  - g. Outlet/Icon colors shall be: Refer to MARINERS Network Standards for color application.
  - h. Approved Manufacturer: Leviton or equal
    - 1) eXtreme Cat 6 QuickPort Jack, blue, Part #61110-RI6
    - 2) Equivalent Manufacturers
      - a) Panduit
      - b) CommScope
2. Wireless Access Points: Category 6A, RJ45, 8-Position, 8-Contact (8P8C), 10 Gb/s, universal module
  - a. The connector module shall be Power Sum rated, with a Power Sum NEXT performance equal to or better than the ANSI/TIA/EIA-568-C.2 Category 6A, pair to-pair NEXT performance specifications.
  - b. The eight-position connector module shall accommodate six-position modular plug modular cords without damage to either the cord or the module.



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- c. The connector module shall be designed for use at the work area (WA), communications room (TR) and/or equipment room (ER) without modification.
- d. The connector module shall be available in both the T568A and T568B wiring configurations within the same module.
- e. The connector module shall have an insulation displacement connection featuring insulation slicing of 23 AWG plastic-insulated solid copper conductors forming a gas-tight connection.
- f. Icons shall be used if offered from the manufacturer.
- g. Approved Manufacturer: Leviton or equal
  - 1) eXtreme Cat 6A QuickPort Jack, Channel-Rated, blue, Part #6110G-RL6
  - 2) Equivalent Manufacturers
    - a) Panduit
    - b) CommScope

## 2.3 FACEPLATES

### A. Faceplates

- 1. The faceplate housing the connector modules shall have no visible mounting screws.
- 2. Faceplates shall be midsize.
- 3. Faceplates shall accommodate four ports, unless noted otherwise on the drawings.
- 4. It shall be possible to install the connector modules in wall-mounted single- and dual-gang electrical boxes, utility poles and modular furniture (cubicle) access points using manufacturer-supplied faceplates and/or adapters.
- 5. The faceplate housing the connector modules shall have the option of being mounted on adapter boxes for surface mount installation.
- 6. The faceplate housing the connector modules shall have a labeling capability using built-in labeling windows, to facilitate outlet identification and ease network management.
- 7. The faceplate housing the connector modules shall provide flexibility in configuring multimedia workstation outlets that respond to present or future network needs such as audio, video, coaxial and optical fiber applications.
- 8. Color shall be same as electrical faceplates.
- 9. Approved Manufacturer: Leviton or equal
  - a. Single-Gang QuickPort Wallplate with ID Windows, 2-Port, white, Part #42080-2WS
  - b. Equivalent Manufacturers
    - 1) Panduit
    - 2) CommScope

## 2.4 SURFACE MOUNT BOXES

- A. The surface mount box shall accommodate connections of any type, UTP.



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- B. The surface mount box shall have internal storage space for slack cabling and a built-in spool for controlling cable bend radius.
- C. Color shall be same as electrical faceplates.
- D. Approved Manufacturer: Leviton or equal
  - 1. Surface-Mount QuickPort Boxes, 2 Port, white, Part #41089-2WP
  - 2. Equivalent Manufacturers
    - a. Panduit
    - b. CommScope

### PART 3 - EXECUTION

#### 3.1 COPPER CONNECTIVITY

- A. 8-position, 8-conductor (8P8C) modular jacks shall be installed in accordance with manufacturer's recommendations and installation guides, and best industry practices.
- B. Pair untwist at the termination shall not exceed ½”.
- C. Data jacks, unless otherwise noted in Drawings or fiber adapter modules are present, shall be located in the bottom position(s) of each faceplate. Data jacks in horizontally oriented faceplates shall occupy the right-most position(s).
- D. Voice jacks, unless otherwise noted in Drawings, shall occupy the top position(s) on the faceplate. Voice jacks in horizontally oriented faceplates shall occupy the left-most position(s).

#### 3.2 FACEPLATES

- A. Shall be flush mount.
- B. Blank inserts shall be installed where ports are not used.
- C. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.
- D. Faceplates shall be installed straight and level.
- E. Faceplates shall be installed at heights as noted on the Drawings.

#### 3.3 WALL PHONE FACEPLATES

- A. Shall be stainless steel surface mount.



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1. Verify with owner prior to purchasing and installation for device compatibility.

3.4 SURFACE MOUNT BOXES

- A. Shall have four ports.
- B. Verify color with owner prior to purchasing and installing.
- C. Blank inserts shall be installed where ports are not used.
- D. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.
- E. Surface mount boxes shall be installed straight and level.
- F. Surface mount shall be installed at heights as noted on the Drawings.

3.5 MODULAR FURNITURE FACEPLATES

- A. Shall have four ports.
- B. Verify color with owner prior to purchasing and installing.

3.6 IDENTIFICATION

- A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

**END OF SECTION 27 15 43**



## **SECTION 27 16 19 - COMMUNICATIONS PATCH CORDS AND STATION CORDS**

### **PART 1 - GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Voice and Data Cross-Connect/Patching Equipment.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

#### **1.2 SUBMITTALS**

- A. Provide product data from manufacturer's specifications.

#### **1.3 WORK INCLUDED**

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.
- B. The work shall include, but not be limited to the following:
  - 1. Furnish and install all copper patch cords/station cords.
  - 2. Furnish and install fiber patch cords/station cords.

### **PART 2 - PRODUCTS**

#### **2.1 APPROVED PRODUCTS**

- A. Approved Copper Patch Cord/Station Cord Manufacturer(s)
  - 1. Leviton
  - 2. Uniprise (CommScope)
  - 3. Panduit



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2.2 COPPER PATCH CORDS/STATION CORDS

A. Category 6 Patch Cords/Station Cords (Telecommunications Outlets)

1. The Category 6/Class E, UTP, patch cord/station cord shall be 4-pair, with 28 AWG stranded copper conductors and 8-position modular plug.
2. The Category 6 modular cord cable shall be UL Listed as Type CMP.
3. The Category 6 patch cord/station cord shall meet or exceed the requirements of ANSI/TIA-568-B.2.1.
  - a. The Category 6 patch cord/station cord color for voice shall be:
  - b. Contractor to verify with owner and MARINERS Network Standards for quantities and colors to be provided.
  - c. Contractor to verify with owner and MARINERS Network Standard for lengths and associated colors to be provided.
  - d. Approved Manufacturer: Leviton or equal
    - 1) Cat 6 Small Diameter High-Flex Patch Cord, 3 ft (0.9 m), blue, Part #6H460-3L
    - 2) Manufacturer Equivalent
      - a) CommScope
      - b) Panduit

B. Category 6A Patch Cords/Station Cords (Wireless Access Points)

1. The Category 6A/Class EA, UTP, patch cord/station cord shall be 4-pair, with 28 AWG stranded copper conductors and 8-position modular plug.
2. The Category 6A modular cord cable shall be UL Listed as Type CMP.
3. The Category 6A patch cord/station cord shall meet or exceed the requirements of ANSI/TIA-568-C.2.
  - a. The Category 6A patch cord/station cord color for voice shall be:
  - b. Contractor to verify with owner and MARINERS Network Standards for quantities and colors to be provided.
  - c. Contractor to verify with owner for lengths and associated colors to be provided.
  - d. Approved Manufacturer: Leviton or equal
    - 1) Cat 6A Patch Cord, 3 ft (0.9 m), white, Part #6AS10-3W
    - 2) Equivalent Manufacturer
      - a) CommScope
      - b) Panduit

PART 3 - EXECUTION

3.1 COPPER PATCH CORDS/STATION CORDS

- A. Copper patch cords/station cords shall be installed as per the requirements specified by the manufacturer's installation guidelines.



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3.2 IDENTIFICATION

- A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.
  - 1. Contractor to provide Panduit Turn Tell labels on each patch cord. Verify with owner and MARINERS Network Standards for labeling schema approved prior to installing labels.

**END OF SECTION 27 16 19**



## **SECTION 27 41 16 - AUDIOVISUAL SYSTEMS GENERAL**

### **1.1 GENERAL DESCRIPTION**

- A. General Description: This specification covers the furnishing and installation of complete audiovisual systems for Santee Community Center Owner. The requirements described in this section include the following:
1. Related Sections
  2. Definitions
  3. Submittals
  4. Qualifications
  5. Quality Assurance
  6. Coordination
  7. Technical Requirements
  8. Delivery, Storage, and Handling
  9. Product Details
  10. Installation
  11. Training, Warranty, and Maintenance
  12. Closeout and Record
- B. Related Sections
1. Division 1 General Requirements
  2. 27 00 00 Communications Systems
  3. 27 05 26 Grounding and Bonding for Communications Systems
- C. Contractor shall provide configuration, programming, and testing services, in addition to the installation of the systems hardware as required.
- D. Furnish and install all cable, cable supports, connectors, wiring, and other accessories necessary to complete the system installation.
- E. It is the intent of the specifications and construction documents that the Contractor shall include all necessary items for a complete and fully operational system. In addition to complete and fully operational, the system must also meet the design intent with regards to special features and functionality mentioned in the specifications or drawings.
1. Work or product not specifically indicated in the specifications or on the drawings, but which is required for a complete and fully operational system as defined above, shall be provided by the Contractor at no additional cost.
  2. The specification of certain products in the specifications or drawings shall not be construed as a release from furnishing such additional products and materials necessary to furnish a complete and fully operational system as defined above.



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1.2 APPLICABLE PUBLICATIONS

- A. The edition of the appropriate code or standard at the time of permitting shall govern all applications.
- B. Codes, standards, and industry manuals/guidelines listed by reference, including revisions by issuing authority, form a part of this specification section to extent indicated. Consider such codes and/or standards a part of this Specification as though fully repeated herein.
- C. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.
- D. Standards: Perform the work in accordance with the following standards:
  - 1. UL 813 – Commercial Audio Equipment
  - 2. UL 1419 – Professional-use Video and Audio Equipment
  - 3. UL 1480 – Speakers for Fire Alarm, Emergency, and Commercial and Professional use
  - 4. UL 1492 – Audio-Video Products and Accessories
  - 5. UL 60065-1 – Audio, Video and Similar Electronic Apparatus
  - 6. ANSI/INFOCOMM 2M-2010, Standard Guide for Audiovisual Systems Design and Coordination Process
  - 7. ANSI/INFOCOMM 3M-2011 Projected Image System Contrast Ratio
  - 8. ANSI/INFOCOMM 4:2012 Audiovisual Systems Energy Management
  - 9. ANSI/INFOCOMM 10:2013 Audiovisual Systems Performance Verification
  - 10. AVIXA V202.01:2016 Display Image Size for 2D Content in Audiovisual Systems
  - 11. AVIXA A102.01:2017 Audio Coverage Uniformity in Listener Area
  - 12. AVIXA F501.01:2015 Cable Labeling for Audiovisual Systems
  - 13. AV/IT Infrastructure Guidelines for Higher Education, by INFOCOMM
  - 14. ANSI/TIA-569d Telecommunications Pathways and Spaces
  - 15. NTSC National Television Standards Committee
  - 16. NEMA National Electrical Manufacturers Association
  - 17. NECA National Electrical Contractors Association, Standards of Installation
  - 18. NFPA National Fire Protection Association 70 “National Electrical Code” (NEC)
  - 19. CCR Title 8 Cal/OSHA Requirements
  - 20. CCR Title 24 California Building Code
  - 21. CCR Title 24 California Electric Code
  - 22. ADA Americans with Disabilities Act General Guidelines
  - 23. FCC Part 15, Part 68
  - 24. IEEE RS 170 variable standard NTSC (color camera broadcast)
- E. Where more than one code or regulation is applicable, the more stringent shall apply.
- F. Cable installation, identification and termination shall be performed in accordance with manufacturer's installation manuals in addition to the above applicable codes.



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- G. In the absence of manufacturer's recommendations on conductor applications, the Contractor shall ensure that the cable selected meets all technical requirements of the location of its installation, and of the equipment to be installed.

1.3 QUALIFICATIONS

A. General

1. The approved Contractor shall be responsible for satisfactory operation of the system and its certification.
2. Approval of the Owner is required of products or services of the proposed manufacturer, suppliers and installers and will be based upon conformance to the specifications.

B. Manufacturer Qualifications

1. System components shall be furnished by manufacturers of established reputation and experience who shall have produced similar equipment and who shall be able to refer to similar installations rendering satisfactory service.

C. Contractor Qualifications

1. Contractor submitting the bid must hold current legally required California State Contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. Pursuant to the notice to contractors calling for bids, contractors providing installation services are required to provide proof of California Contractor's license issued by the California Contractors License Board (CSLB) at time of bid submittal.
2. Contractor has been in business providing similar service required by this section for not less than five years.
3. Firm can list a minimum of three projects of similar scope successfully completed in the past 24 months, indicating the location, type of system installed, total contract amount, date completed, and include persons and telephone number to contact.
4. Hold current, legally required state registrations required to meet local requirements for submittal drawings.
5. Meet insurance requirements set by the Owner.
6. Have primary manufacturer (Extron)-trained and certified engineering, field technicians and programming staff.
7. Must employ, or strategically partner with an Extron Authorized Programmer (EAP) having a minimum of five (5) years of related work experience. Provide documentation that demonstrates this. Programming experience shall include:
8. Basic AV System Functionality
9. Custom GUIs
10. Audio DSP
11. Lighting and Shade integration
12. Videoconferencing Control
13. Contractor must be an Extron Platinum Reseller



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14. Contractor must be an authorized supplier and installer for all equipment.
15. Contractor's Project and Installation team must include at a minimum one (1) AVIXA CTS-I and one (1) CTS-D, and one (1) Extron XTP-E and one (1) XTP-T certified individual.
16. Indicate complete and total compliance with the provisions of these Specifications by letter or by submittal of the bid response forms, signed by an officer of the corporation, or a principal if other ownership exists. In addition, the letter or forms shall include a complete listing of exceptions, if any.

D. Subcontractors

1. No subcontracting will be permitted, unless specifically identified in the bid submission.
2. The Audiovisual Contractor shall have sole responsibility for the satisfactory implementation of the work in this section, regardless of any subcontract arrangement.

E. BID RESPONSE

F. Bidders Responsibility

1. Contractor is responsible for verifying actual conditions by visiting the site if desired, reviewing the Specifications and drawings, and to advise the Owner in writing of any conditions which may adversely affect the work. If any necessary exceptions are discovered, Contractor shall immediately notify the Owner for resolution prior to any change in the design or the scope, and present in formal request for information (RFI) format any resultant claim for additional compensation.
2. The Bid Response must fulfill the intent of the Drawings and Specifications to the satisfaction of the Owner to qualify as an acceptable and responsive Bid Response.

G. Substitutions

1. Catalog and/or model numbers for Owner-approved equipment and systems are included as a part of these specifications.
2. Any substitution proposed by Contractor for catalog numbers and brands or trade names noted or specified herein shall be solely at the Contractors risk. The Owner maintains sole authority to hold a review of substitutions, and sole authority to approve or disapprove of substitutions for any reason. Approval or disapproval of any proposed substitutions shall not be considered grounds for claims of delay.
3. The Owner's acceptance of substitutions shall not relieve Contractor from complying with the requirements of the drawings and Specifications. Contractor shall be responsible, at Contractor's sole expense, for any changes resulting from Contractor's substitutions that affect other parts of Contractor's own work or the work of others.
4. Any substitute equipment, products or systems incorporated into this Project without prior written approval from the Owner and Audiovisual Consultant will be



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considered defective and shall be rejected. Rejected items shall be promptly removed from the Project and replaced with the specified materials and equipment by the Audiovisual Contractor at no increase in Contract price and shall not be considered grounds for claims of delay.

- H. Technical Bid Submission: At bid submission, submit one (1) hard copy and one (1) electronic PDF copy to the Owner's Representative of the following:
1. An equipment list with names of Manufacturers of primary systems including model numbers and technical information on equipment proposed.
  2. A letter from the manufacturer(s) stating the Contractor is an authorized integrator/installer of the proposed primary systems.
  3. Indicate complete and total compliance with the provisions of these Specifications by letter or by submittal of the bid response forms, signed by an officer of the corporation, or a principal if other ownership currently exists. If there are exceptions to the specifications, submit a statement listing every technical and operational parameter wherein the submitted equipment or system may vary from that which was originally specified. If the submitter fails to list a particular variance and his submittal is accepted but is subsequently deemed to be unsatisfactory because of the unlisted variance, the submitter must replace or modify such equipment at once and without cost to the Owner.
  4. Complete Bill of Materials (BOM) with Quantities and Unit Pricing.
  5. Non-material Cost Breakdown, including the following:
    - a. Engineering labor
    - b. Pre-installation labor (fabrication, rack building, etc.)
    - c. Installation labor (onsite installation)
    - d. General and Administrative expenses (shipping, insurance, permits, etc.)
    - e. Fees (e-Waste disposal fees, etc.)
    - f. Taxes (include and indicate sales tax)
    - g. Maintenance Contract (shall be listed as an option on the proposal)
  6. California Contractor's license
  7. Subcontractor Information: Responsibilities and qualifications
  8. Key Personnel
    - a. See "QUALIFICATIONS" section for required project personnel qualifications.
    - b. Provide certification information for the Project Manager, Field Installation Supervisor and other key personnel who will be assigned to the project
    - c. Indicate educational, factory and industry certifications for involved personnel
    - d. Include a list of all staff that will be dedicated to the project along with their resumes and/or listing of technical qualifications.
  9. Failure of Contractor to submit the above information shall be considered non-responsive to the bid requirements and sufficient cause for bid rejection.
- I. Examination of Site and Verification of Existing Conditions



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1. Contractors may request a site visit prior submitting proposal. Requests shall be sent to the Owner's Representative.
  2. Contractor shall be familiarized with existing conditions prior to submitting bid and shall be prepared to carry out the work within the existing limitations. Failure or neglect to do so shall not relieve Contractor of their responsibilities nor entitle them to additional compensation for work overlooked and not included in his bid.
  3. Existing structures and utilities shown on the contract drawings are obtained from project drawings and exploratory field examination. Contractor shall verify existing conditions and required dimensions at all sites, including those shown on the drawings, by measurement at all job sites. Contractor shall notify the Owner of exceptions before proceeding with the work.
  4. Contractor shall confirm the availability of the proper power source for each piece of specified equipment, through site visits and drawings, as necessary. Where proper power does not exist, Contractor shall identify this situation to the Owner for guidance. Should the Owner direct the Contractor to provide the necessary power, it shall be provided using equipment and methods authorized by the Owner.
- J. Data Accuracy: Absolute accuracy of information regarding existing conditions cannot be guaranteed. The Drawings and Specifications are for the assistance and guidance of Contractor and exact locations, distances, and elevations will be governed by actual field conditions. Where variations from the bid documents are required, such variations shall be approved by the Owner.
- K. SUBMITTALS
- L. Pre-construction Submittals
1. Product Data: Submit product information for components specified herein prior to the purchase and installation of equipment. Indicate, either on a product index sheet or directly on each product's data sheet, where this information is not already provided on the sheet, the manufacturer, model/part number, accessories and options selected, color (if applicable), and a brief product description.
  2. Written Testing Procedures: Submit written testing procedures for initial systems testing and systems acceptance testing.
- M. Shop Drawing Submittals
1. General: Submit the following in accordance with the Conditions of Contract and Division 1 Specification Section.
  2. Prior to Fabrication:
    - a. Panels, plates, and designation strips, including details and samples relating to terminology, engraving, finish, and color
    - b. Custom designed consoles, tables, carts, support bases, and shelves
    - c. Schematic drawings of custom circuitry
    - d. Equipment modifications
    - e. Touch screen menus
    - f. Pushbutton control panel layouts including the labels for all buttons



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- g. Handheld remote-control panel layouts including the labels for all buttons
  - h. Audio processor configuration files. It is understood that these files will be modified during system commissioning, but basic routing and processing must be complete and submitted prior to system fabrication.
3. Prior to Assembly and Installation:
- a. Provide system functional line drawings for all systems. Include equipment names and model numbers (e.g., "Program Amplifier - Crown CT-400"). Clearly label each item of equipment shown on the drawing with the manufacturer's terminal number or input/output designation (e.g., "Mic 1-In", or "Record Out-Left").
  - b. Provide equipment rack elevation and patch panel assignment drawings. Provide labeling on the functional diagrams, rack elevations, patch panels, and on the equipment controls that is consistent and uniform.
  - c. Provide full-scale drawings of custom plates and panels indicating exact lettering, critical dimensions, and finishes.
  - d. Provide cable run lists. Clearly show at each terminal point the type of connector to be used. Include typical wiring details of each connector. Note where shields are connected and where they will float to ensure the integrity of the grounding system. Indicate cable types and, where appropriate, color codes. Assign wire numbers and patch bay locations to every wire and patch point in the drawing
  - e. Equipment modification drawings: Include details of modifications that change or void manufacturers' warranties.
  - f. Provide schematic drawings of custom circuitry. Include receptacle pin numbers and component callouts. Show details of custom resistive attenuation and/or combining networks, filters, or pads which may be required in the assembly. Show point-to-point wiring drawings for control system modules and interfaces, and for switches and relays in audio, video, or control systems.
  - g. Submit written testing procedures to be performed during pre-testing and acceptance testing. Provide for each test item the minimum acceptable outcome for that test.
  - h. Provide a list of test equipment, including manufacturer, description, and model number, of equipment that will be employed in the testing and adjustment of the installed systems.
  - i. List equipment which is to be connected to the building or campus computer network. Provide an Excel spreadsheet listing each piece of equipment.
    - 1) Indicate which equipment if any requires static addressing.
    - 2) Indicate which equipment requires specific network and/or subnet configuration.
    - 3) Indicate equipment which is likely to generate a high volume of network traffic.
    - 4) Indicate equipment with particular QOS requirements.
  - j. Provide a full-scale mockup of the recognition plates as described in the "INSTALLATION" section.



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1.4 DELIVERABLES AND CLOSEOUT DOCUMENTATION

- A. Phase One: Notwithstanding requirements specified elsewhere, submit the following labeled as the "Operating and Maintenance Manual" within ten (10) days after Final Acceptance of the Installation to the Owner's Representative:
1. Record Drawings: Submit two (2) copies of revised versions of drawings as submitted in the "Shop and Field" and "Equipment Wiring Diagrams" Submittals showing actual device locations, conduit routing, wiring and relationships as they were constructed. Include nomenclature showing as-built wire designations and colors. Drawings shall include room numbers coinciding with Owner space planning numbering. Drawings shall be submitted in electronic editable AutoCAD files, in ".dwg" format, on USB flash drives.
  2. Operations and Maintenance Manuals: Submit two (2) copies of each of the following materials in bound manuals, as well as electronic PDF copies on USB flash drives, with labeled dividers:
    - a. A final Bill of Material for each system.
    - b. Equipment Instruction Manuals: Complete, project specific comprehensive instructions for the operation of devices and equipment provided as part of this work.
    - c. Manufacturers' Instruction Manuals: Specification sheets, brochures, Operation Manuals, and service sheets published by the manufacturers of the components, devices and equipment provided.
    - d. Include information for testing, repair, troubleshooting, assembly, disassembly, and recommended maintenance intervals.
    - e. Provide a replacement parts list with current prices. Include list of recommended spare parts, tools, and instruments for testing and maintenance purpose.
    - f. Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified herein.
    - g. Describe in the "Operation" section, typical procedures necessary to activate each system to provide for the functional requirements as listed under the System Description. Include normal settings for equalizer, amplifier, signal processing, and user-operated controls (as established during system check-out) in tabular or pictorial form.
    - h. Warranties: Provide an executed copy of the Warranty Agreement and copies of all manufacturers' Warranty Registration papers as described herein.
  3. Submit a copy of control system programming, including touch screen layouts, capable of being revised and compiled.
  4. Provide loose equipment, such as remotes, spare batteries, keys, cables, and other hardware supplied with the audiovisual equipment installed, especially equipment required for the use and maintenance of the audiovisual systems.
- B. Phase Two: Within fourteen (14) days of receipt of engineer reviewed Operating and Maintenance Manual (Phase One), submit three (3) USB flash-drives with an electronic



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copy in AutoCAD editable .dwg format of the reviewed Record Drawings and a copy of the reviewed Operating and Maintenance Manuals to the Owner's Representative.

1. The contractor shall provide to the Owner's Representative one (1) copy of software capable of viewing the .dwg files on the USB flash-drives.
2. Sufficient information, (detailed schematics of subsystems, assemblies, and subassemblies to component level) clearly presented, shall be included to determine compliance with drawings and specifications.
3. Any and all programming (switcher, touch panel interfaces, etc.), configurations, code,
4. username/passwords, and accessibility rights associated with this project shall be included in the closeout package and shall become the property of the Owner.

#### 1.5 CHANGES

- A. Before proceeding with changes or claims for extras, Contractor shall provide written notice, by submitting a formal RFI (Request for Information) form to the Owner's Representative for review, and substantiate any and all actual costs of each change item or aspect of any claim, and ultimately perform no work before securing formal written approval from the Owner via a formal Approved Change Order by the Owner.

#### 1.6 NOTIFICATION

- A. Contractor shall not shut off any existing systems. Contractor shall give the Owner at least (14) calendar day notice of any requirement to shut off or interfere with other systems. The Owner will arrange and execute any shutdown at its sole discretion and only upon such action not impacting the function of any necessary system at particular site(s) effected, as determined exclusively by the Owner.

#### 1.7 INTERFERENCE WITH THE FACILITY

- A. Transportation and storage of materials at the facility, work involving the facility, and other matters affecting the habitual use by the Owner of its buildings, shall be conducted so as to cause the least possible interference's, and at times and in a manner acceptable to the Owner. Contractor shall make every effort to deliver equipment per the schedule required by the project.

#### 1.8 WARRANTY

- A. Contractor shall guarantee the installation and workmanship free of any defects for a period of one (1) year after final acceptance of the installation.
- B. Contractor shall provide a warranty for all hardware components of the system for a period of one (1) year minimum after final acceptance of the installation. The warranty shall include repair, up to replacement of the defective piece of equipment during the



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Warranty period. Hardware included but not limited to are matrix switcher(s), displays, videoconferencing codecs, and audio equipment.

- C. Activate manufacturers' equipment warranties in the Owner's name to commence on the date of acceptance. Provide the Owner with warranty documentation when submitting operation and maintenance manuals. In the case of Contractor-modified equipment, the manufacturer's warranty is normally voided. In such cases, provide the Owner with a warranty equivalent to that of the original manufacturer.
- D. Purpose
  - 1. The Contractor shall repair any system malfunction or installation deficiency discovered by the Owner or their representatives during the warranty period.
  - 2. The Contractor shall correct any installation deficiencies found against the contract drawings and specifications discovered by the Owner or their representatives during the warranty period without additional compensation, unless authorized by the Owner prior to commencement of any work.
- E. Preventative Maintenance Visits:
  - 1. Quarterly Inspection/Preventative Maintenance visits shall be performed for a period of one (1) year commencing after final testing and acceptance of equipment and components. (Four (4) visits total)
  - 2. The visits shall cover equipment, firmware, and programming related to this contract, and shall be performed with no additional costs to the Owner.
  - 3. Services shall include dusting, cleaning of filters, inspecting and adjusting of systems, equipment, and any firmware and software updates.
  - 4. A preventative maintenance visit log shall be completed at each visit and submitted to the Owner. Log shall include all tasks performed, all updates performed, and other retrievable system statistics such as projector lamp hours used/remaining.
- F. Commencement: The warranty begins at the time of issuance of the statement of "Final Acceptance of the Installation" by the Owner, as determined to be the issuance of the formal Notice of Completion of the project by the Owner.
- G. Transferability: The warranty shall be transferable to any person or persons at the discretion of the Owner.
- H. Transmittal: A copy of this Warranty shall be delivered to and signed for by the Owner's representative whose primary responsibility is the operation and care of these systems. A copy of the signed Warranty document shall be delivered for review as part of the Final Submittals.
- I. Registration: Register Warranty papers for all equipment and software in the name of the Owner. Furnish reproductions of all equipment Warranty papers to the Owner's Representative with the Final Submittals.



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- J. Sub-Contracting: Warranty service work may not be sub-contracted except with specific permission and approval by the Owner.
- K. Resolution of Conflicts
  - 1. The Owner retains the right to resolve unsatisfactory warranty service performance at any time by declaring the work unsatisfactory, stating specific areas of dissatisfaction in writing.
  - 2. If the Contractor does not resolve such stated areas of dissatisfaction within thirty (30) days, the Owner may appoint any alternative service agency or person to fulfill the terms of the Warranty; the cost of which shall be borne by the contractor. This action may be taken repeatedly until the Owner is satisfied that Warranty service performance is satisfactory. Satisfactory resolution of a malfunction shall be considered adequate when the device, equipment, system, or component which is chronically malfunctioning is brought into compliance with the standards of performance as contained herein and published by the manufacturers of the equipment installed.

1.9 TRAINING

- A. On-Site Training
  - 1. General: Present, review and describe equipment and materials to the Owner and Owner's operating personnel and fully demonstrate the operation and maintenance of the systems, equipment and devices specified herein.
  - 2. Training shall comprise of two separate levels of training:
    - a. User Group upon substantial completion of the project
      - 1) User group training shall include a site/building walk through indicating locations of equipment and their usage
      - 2) User group training shall include the operation of the system.
    - b. Maintenance Group upon completion of the project prior to close out
      - 1) Troubleshooting techniques in hardware and software
  - 3. The training shall cover the overall system, each individual system, each subsystem, and each component. The training shall also cover procedures for normal operations and failure modes with response procedures for each failure. Each procedural item must be applied to each equipment level.
  - 4. Duration: Provide on-site training on each system for each group of designated representatives of the Owner at a location convenient to the Owner.
    - a. Provide one (1) two-hour training sessions for up to a maximum of eight (8) staff members. Staff members shall be trained on basic usage of the systems.
    - b. Provide one (1) four-hour advanced training session for SBCCD IT technical specialist staff members.
  - 5. On-site training shall commence upon Owner acceptance of the project installation.



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1.10 SAFEGUARDS AND PROTECTION

- A. Barriers: Provide and maintain suitable barriers, guards, fences, and signs where necessary to accommodate the safety of others relative to and/or for the protection of this work. Coordinate with the Owner.
- B. Regulations: Comply with OSHA, Federal, State, and local regulations, and standards pursuant to this work.
- C. Protection: Protect all materials and equipment from damage and theft up to date of final acceptance. Prevent the entry or adhesion of any and all foreign material, covering equipment with temporary protective material suitable for this purpose, if necessary.
- D. Finishing: Check, clean, and remove defects, scratches, fingerprints and smudges from all equipment and devices, as well as from any disturbed pre-existing conditions, immediately prior to Acceptance of the Installation.
- E. Damage: Replace all damaged or defective material or work at no additional cost prior to Final Acceptance, including ceiling tiles.
- F. Documentation: Provide written description of accidents by workers, and staff of any incident occurring on the project. Report incident in writing to Owners representative immediately and to the Project Manager for follow up.

1.11 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery
  - 1. Do not deliver products to the site until protected storage space is available.
  - 2. Coordinate materials delivery with installation schedule to minimize storage time at jobsite.
  - 3. Unless materials are rack-mounted before arriving at the site, deliver materials in manufacturer's original, unopened, undamaged packaging and containers with identification labels (name of the manufacturer, product name and number, type, grade, UL classification, etc.) intact.
  - 4. Immediately replace equipment damaged during shipping at no cost to the Owner, so as not to impact the construction schedule.
- B. Storage and Protection
  - 1. Store materials in clean, dry, ventilated space free from temperature and humidity conditions (as recommended by manufacturer) and protected from exposure to harmful weather conditions.
  - 2. Comply with manufacturer's storage requirements for each product.
  - 3. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris, and traffic.
  - 4. Storage outdoors covered by rainproof material is not acceptable.



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5. Provide heat where required to prevent condensation or temperature related damage.

C. Handling

1. Handle materials and equipment in accordance with manufacturer's written instructions. Handle with care to prevent damage, breakage, denting, and scoring.
2. Do not install damaged materials and equipment. Replace damaged equipment at no cost to the Owner.

1.12 EQUIPMENT COMPATIBILITY REQUIREMENTS

- A. While individual items of equipment may meet the equipment specifications and in fact meet the system specifications, the total system shall be designed so that the combination of equipment actually employed does not produce any undesirable effects such as signal distortion, noise, transients or crosstalk interference's when electrically associated with itself or other equipment.

1.13 OWNER'S RIGHT TO USE EQUIPMENT

- A. The Owner reserves the right to use equipment, material and services provided as part of this work prior to Acceptance of the Work, without incurring additional charges and without commencement of the Warranty period.

1.14 SYSTEM DESCRIPTION

A. General

1. This project's audiovisual systems are based on a number of standard room types. Each room shown on the drawings is designated with a type. Each room of a certain type is similar to others of its type, with minor layout differences to accommodate project architecture.
2. Refer to the drawings for the quantities of each type of room.
3. Refer to the project drawings for specific audiovisual interface information.
4. In circumstances where the specifications and drawings conflict, the drawings govern quantity and the specifications govern quality.

B. General Technical Requirements

1. Screen shall be sized according to image requirements set out in the AV standards document
2. Lighting near the projection screen or monitor will be zoned separately from the room lighting to help reduce reflection
3. Lighting and shade controls shall be integrated into local AV system control panel.



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4. Sound systems shall operate at 25dB above typical ambient noise level
5. Audiovisual system shall be integrated with Mass Notification and/or Fire Alarm Systems for audio override in the event of an emergency announcements or fire alarm conditions.

C. ASSISTIVE LISTENING SYSTEMS

1. Rooms with permanent systems seating 50 or more shall be equipped with dedicated assistive listening systems
2. The building will be provided with two portable systems that can be checked out for use in smaller rooms as required
3. All systems will be provided with receivers, chargers, batteries, neck loops, headphones, storage case and other accessories as required to provide a complete and working system

D. EVENT CENTER

1. Divisible Room that can be combined into one large space. When divided, sources, displays, audio remain local to room. When combined, all sources can be routed to all displays, audio is combined as a single zone
2. Projector and Projection screen and flat panel display located in each half of room
3. AV rack equipment located in Telecom room
4. Control panels and inputs located in each half of room.
5. Inputs include hard wire inputs and wireless presentation devices
6. Control Panel will be provided in each half of room. When combined, panels will control all components and sync with each other.
7. Ceiling mounted speakers will reproduce program and speech audio.
8. Provide multichannel wireless microphone for each half of room with
  - a. (1) Handheld transmitter
  - b. (1) Lavalier transmitter
  - c. (2) Boundary mic transmitter
  - d. Charging case, remote antenna system and accessories as needed
9. Dedicated ALS system for each half of room per C above

E. LOBBY

1. Dual displays
2. Local inputs and signage players for each display
3. Control panel located behind information desk as shown on drawings

F. MULTIPURPOSE ROOM



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1. Divisible Room that can be combined into one large space. When divided, sources, displays, audio remain local to room. When combined, all sources can be routed to all displays, audio is combined as a single zone
2. Projector and Projection screen and flat panel display located in each half of room
3. AV rack equipment located in Telecom room
4. Control panels and inputs located in each half of room.
5. Inputs include hard wire inputs and wireless presentation devices
6. Control Panel will be provided in each half of room. When combined, panels will control all components and sync with each other.
7. Ceiling mounted speakers will reproduce program and speech audio.
8. Provide multichannel wireless microphone for each half of room with
  - a. (1) Handheld transmitter
  - b. (1) Lavalier transmitter
  - c. (2) Boundary mic transmitter
  - d. Charging case, remote antenna system and accessories as needed
9. Outputs for ALS system in each each half of room per C above

1.15 TECHNICAL REQUIREMENTS, AUDIOVISUAL SYSTEMS

A. General

1. The following information is intended to provide the design concepts and is not an exhaustive description of the related systems.
2. Contractor shall be responsible for providing equipment, cabling, mounting hardware, cable management, licenses, and software to achieve the specified system performance described herein, unless otherwise noted.
3. Per ADA General Guidelines (2010):
  - a. All displays must not protrude more than 4" from the wall, unless there is fixed furniture beneath the display, or mounted at  $\geq 80"$  A.F.F. to bottom of the display.
  - b. Display systems must provide closed captioning accessibility. See section 508 for further information.
  - c. Assistive listening systems must be provided in assembly areas. See section 219 for further information.
  - d. Control systems must be in reachable range. See section 308 for further information.

B. Performance Standards

1. Meet the following performance standards with each system, unless restricted by the published specifications of a particular piece of equipment. Notify the Design Consultant of any restrictions.
2. Audio System
  - a. Program Audio System:
    - 1) Frequency Response:  $\pm 3$  dB per octave band, 100 Hz to 12,000 Hz. 3dB per octave roll off below 100Hz and above 12 kHz.



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- 2) Total Acoustical Harmonic Distortion: Less than 2% at 90 dBc (1kHz reference) at four feet (1,220mm) above finished floor in the middle of the room.
  - b. Distributed Audio System:
    - 1) Frequency Response:  $\pm 3$  dB per octave band, 125 Hz to 10,000 Hz. 3dB per octave roll off below 125 Hz and above 10 kHz.
    - 2) Total Acoustical Harmonic Distortion: Less than 2% at 85 dBc (1kHz reference) at four feet (1,220mm) above finished floor in the middle of the room.
  - c. Adjust the gain structure for all audio system components (mixer input to amplifier output) to achieve the highest signal-to-noise ratio, 75 dB from 50 Hz to 15 kHz minimum.
  - d. Ensure that the audio frequency response of the electronics system with equalizers bypassed varies less than  $\pm 1$  dB from 50 Hz to 12 kHz.
  - e. The electronic system audio distortion shall be less than 0.5% at 1 kHz at the equipment's rated input signal level.
  - f. Sound Output Capability: Provide program levels of not less than 95 dB and speech reinforcement levels of not less than 85dB in the seating area without objectionable distortion, rattles, or buzzes, employing as test signals several different samples of recorded music and microphones applied at each system input.
  - g. Hum and Noise: Hum and noise shall be inaudible (below the background noise level of the space) under normal operation and as observed in normal seat locations.
3. Projection Systems:
- a. Image size and clarity: Mount the video projector as indicated on the drawings and project the image onto the projection screen. Projected images shall be of maximum width and maximum height, centered on screen. Image tests shall utilize standard AMI test slides and similar video media to establish any image sizes on the screen.
  - b. Geometric Distortion: Corrected geometric distortion using physical and/or optical adjustments only. Only use electronic or digital correction when these are called for by the design intent.
  - c. The total averaged light output from a projector, in lumens, shall be  $\pm 15\%$  of that specified by the projector manufacturer.
  - d. The light falloff from the center of the projected image to four corners, as measured at the projected image plane, shall not exceed 50% for video projector images or 35% for slide projector images.
  - e. Securely mount and brace projectors, lenses, and mirrors so there will be no observable movement in the image induced by motor vibration or other mechanical operations.
4. Control:
- a. Provide IP-controlled power control interfaces to devices not provided with these,
  - b. Whether power control accessories are listed in this Section or not. Verify functional operation for specified control operations.



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- c. Illuminated feedback of the active function via illuminated or shaded pushbutton at operator and wired remote control stations.
- d. Wireless systems shall neither be the source of, nor be affected by, radio frequency interference to/from external signal devices.
- e. Take ergonomics into account when designing user interfaces. Be aware that the level of technical inclination will vary between users. Follow these guidelines:
- f. Graphics:
  - 1) Avoid abbreviations
  - 2) Size lettering at 1/8" minimum
  - 3) Maintain background to lettering contrast
- g. Positive logic: Avoid conditions which may cause command synchronization conflicts (i.e., alternate action (toggling) on/off without power reset of feedback. Provide power sensors or other devices where necessary to ensure that positive logic conditions are maintained.
- h. Timing: Prevent two or more commands being sent simultaneously to the same piece of equipment.
- i. Linking: Provide linking of functions to require the fewest number of user actions to effectively control the equipment.
- j. Clearing: Ensure that each media selection clears the previous audio and visual selection (i.e. Selecting COMPUTER clears the audio as well as video section of the previous Blu-ray disk selection.
- k. Defaults: Establish default power-up conditions for the system including device audio levels, warm-up routine, power conditions, switcher status and other default conditions as required by the Owner or Owner's representative.
- l. Volume Memory: Provide easy-to-use memory for volume settings associated with each particular source device. These settings shall be maintained between alternate selections during each use – from power on to power off.
- m. Status Indication: Buttons (hard and soft) which incorporate indicator light or inverted illumination capabilities shall be addressed through the software and programming.
- n. Failsafe: No operation or sequence of operations shall cause the control system to become inoperable or interfere with further processing, correct operations, or execution of commands.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Product Acceptability: Products sections contain lists of Owner acceptable products. If product substitutions are proposed, they must be made based upon a comparison of equivalence to the product specified. Considerations may include but shall not be limited to functional, physical, aesthetic and/or interface aspects. The Owner shall be the sole judge of whether or not a submitted substitution is deemed to be "equivalent" to that specified.



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- B. Manufacturers Specification Reference: Where a specific material, devices equipment or systems are specified directly, the current manufacturers' specification for the same becomes a part of these specifications, as if completely elaborated herein.
- C. Equipment shall be new and the current model of a standard product of a manufacturer of record. A manufacturer of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied.
- D. Contractor to provide all equipment, unless otherwise noted.
- E. No "End of Life" or "End of Sale" products shall be used. The manufacturer's suggested replacement shall be proposed. If no replacement is made available by the manufacturer, propose an equivalent product for approval.
- F. For each item of equipment offered, manufacturer shall maintain:
  - 1. A factory production line.
  - 2. A stock of replacement parts.
  - 3. Engineering drawings, specifications, operating manuals, and maintenance manuals.
  - 4. Manufacturer shall have published and distributed descriptive literature and equipment specifications on each item of equipment offered.
- G. Serial Numbers: Provide to the Owner's Representative a full list of major equipment serial numbers.
- H. Complete System: Auxiliary and incidental equipment necessary for the complete operation and protection of the systems specified herein shall be furnished and installed as if specified in full.
- I. Similar Devices: Similar devices within a system shall be identical unless specific variances are required by the Owner.
- J. Safety: Unless otherwise specified, equipment shall be UL rated individually and listed as an assembly. Electronic equipment shall be of the dead front type, having no exposed live electrical connections, terminals or exposures to hands-on operating surfaces or other exposed surfaces during any power-on condition. Every live electrical connection, terminal or exposure shall be covered with durable, removable insulating material.
- K. Rack Mounting: Rack-mounted electronic equipment shall be specifically designed or modified for standard 19-inch rack mounting unless otherwise noted.
- L. No contractor-proprietary equipment will be permitted without prior approval from the Owner.
- M. Manufacturer's Recommendations: Components and devices shall be operated in accordance with recommendations of the manufacturer and shall contain sufficient permanent identification to facilitate replacement.



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2.2 CUSTOM FABRICATION

- A. Remote Control Panels and Interface Plates. Fabricate with 1/8 inch (3mm) thick #6061-T6 aluminum material. Finish brushed with 150 grit paper. Anodized finish to be black or as approved by the Architect.
- B. Equipment Rack: Provide power receptacle strips, with "U" ground outlets. Power receptacle strips shall be mounted on the rear interior of the rack space on the left side as viewed from the rear. Insulate power receptacle strips from the rack. Power receptacle strips shall be Middle Atlantic or approved equal. Provide UL-approved LED work lights magnetically attached on the upper left interior panel of each rack space.
- C. Audio Transformers: Provide appropriate impedance ratio and power handling capacity for the function intended of audio transformers specified in the system.
- D. Networks and Pads: Provide networks and pads as shown on the drawings or as required to achieve proper impedance matching and levels. Networks and pads shall be balanced. 0.5-watt, 5% composition resistors shall be soldered to fixed connection points at each end.
- E. Loudspeaker Niches: Loosely fill with glass fiber to 2 lbs./cu. ft. density prior to installing loudspeakers.
- F. Labeling: Provide permanently mounted 1/32" thick by 1/4" high black engraved or anodized, brushed aluminum labels with 1/8" engraved lettering for each piece of equipment and every user-adjustable control and input on the audiovisual equipment. Provide 3/8" to 1/2" high permanent labels on the back of each piece of equipment. Label should be white with black lettering. Label adhesive must be permanent.
- G. If the serial number of a piece of rack-mounted equipment is not visible on the rear panel, provide a visible, permanently attached label on the equipment, duplicating the serial number.
- H. Rack Shelves/Mount Adapters: Provide the appropriate factory or custom rack shelves/mount adapters for equipment installed in the audiovisual equipment rack, whether specifically itemized or not. Acceptable manufacturers for custom rack adapters: Middle Atlantic, Winsted, APC/Stantron.
- I. Provide security covers or shaft locks for all level controls, as appropriate, on all equalizers, crossovers, signal delays, and other adjustable signal processors.
- J. System Functional Diagrams: Provide reduced-size as-built functional diagram for the control, audio, and video system. Frame with acrylic cover, or laminate drawing, and mount adjacent to equipment rack.
- K. Seismic Safety: Mount and brace permanently installed equipment to the building structure per the most stringent of applicable codes and regulations to minimize potential damage to personnel or equipment from foreseeable seismic events. Bolt audiovisual equipment racks to the floor to prevent toppling. Brace hanging audiovisual



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and associated equipment both to minimize sway and to prevent detachment from the overhead structure.

L. Labels

1. All labels for all cabling with connection to the audiovisual equipment shall be clearly labeled to identify the connected device or purpose. Labels shall be vinyl wrap with clear over lay so as not to become unraveled and shall not be made of plastic. Labels shall be placed as close to the wire termination point as possible and not placed on equipment that can be removed or replaced.
2. All labels for audiovisual equipment shall be clearly applied so as to easily identify the device or system served. Provide labels for all mounted and installed equipment. Labels shall be vinyl and not made of plastic.
3. Self-laminating adhesive laser labels
4. Machine printable with a laser pointer
5. Color: White label with black lettering
6. Use Helvetica font, 12-point text

2.3 MISCELLANEOUS

A. Pass-thru Faceplate

1. Single gang
2. Shall contain a recessed, upward facing bull nose.
3. Color: White
4. Acceptable Part number: Eaton 35M1W-SP-L, or equal.

B. Cable Lace Bar

1. Acceptable Part number: Middle Atlantic LBP-1A, or equal.

C. Rack Screws

1. 10-32 thread.
2. Acceptable Part number: Middle Atlantic HTX, or equal.

2.4 WIRE AND CABLE

1. General: Cables shall be plenum-rated if installing in plenum environments.
2. Serial Control/Audio:
  - a. Size conductor gauge according to circuit load and wire run length.
  - b. Acceptable Part number: Extron 22-15x-03, or equal.
3. Speaker
  - a. Size conductor gauge according to circuit load and wire run length.
  - b. Acceptable Part number: Extron 22-15x-03, or equal.



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4. HDMI (patch cables)
  - a. Acceptable Part number: Extron 26-663-0x (x= length).
5. Shielded Twisted Pair for Extron DTP and XTP Systems
  - a. SF/UTP construction- four unshielded twisted pairs inside an overall braid and foil shield.
  - b. Certified to 475 MHz bandwidth at distances up to 100 meters
  - c. Meets performance requirements of HDBaseT Alliance
  - d. Acceptable Part number: Extron 22-235-03.
6. Pre-terminated Shielded Twisted Pair for Extron DTP and XTP Systems
  - a. SF/UTP construction- four unshielded twisted pairs inside an overall braid and foil shield.
  - b. Certified to 475 MHz bandwidth at distances up to 100 meters
  - c. Meets performance requirements of HDBaseT Alliance
  - d. Acceptable Part number: Extron 26-702-xx (x= length).
7. Other cable and cable/interface combinations must be pre-approved by both the manufacturer and the Owner, prior to installation.
8. AV Contractor shall follow the manufacturers' recommendation for cabling or the minimum requirements of the Specifications and Drawings, whichever provides for the most stringent requirements.
9. Wire and cable sizes, number of conductors, shielding, or other data listed in this Specification or shown on Drawings are a guide to the correct product required to achieve a working system and represent the minimum acceptable equipment.
10. Use proper grounding practices to eliminate shorts, ground faults, ground loops, RF interference, voltage fluctuations, foreign voltages, and open circuits.
11. Audiovisual cables run underground, under slab, or in slab shall be installed in conduit and rated for direct burial application. Cables above hard ceiling or inaccessible areas shall be installed in conduit. Stub up conduits from within walls into accessible spaces.
12. Existing pathways, conduits, j-hooks, and cable trays shall be utilized where possible and while maintaining a 40% fill ratio.
13. Where existing pathways are not present or available, AV Contractor shall provide appropriate pathway support infrastructure in accordance with the drawings and with not more than 60" between supports.
14. AV Contractor shall field verify existing pathways are adequate prior to cabling rough-in.
15. All cables run in environmental air handling spaces shall be plenum rated. Provide proper J-hooks for cables not run in conduit. Provide plenum-rated and approved cable ties in plenum spaces.
16. Wiring shall be grouped and harnessed to facilitate access to all equipment, as well as maintenance and replacement of equipment.
17. All cable shall be labeled at origin and termination, referencing to a master legend schedule as shown on "As-Built" Record Drawings. Labeling and any splice locations shall be noted on "As-Built" Record Drawings.
18. All final labeling shall be with machine-generated printed labels, specifically made for cable labeling. No handwritten labels will be accepted. All wiring



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including power cords and feeds, network connections, and system cabling shall be fitted with a machine generated label identifying the device or point served. The ID marker for each label shall have the device number and name.

19. Cabling shall be sized and installed according to National Electric Code requirements.
20. Any cabling or raceway exposed to weather shall be rated for that use.
21. Provide blank cover plates for wall, ceiling, and floor boxes reserved for future audiovisual equipment or interfaces. Blank plates shall match adjacent device plates.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Perform this work in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.
- B. Aesthetics are an important consideration in this installation. Components shall be installed so as to have aesthetically pleasing results per Owner requirements. Actual locations of visible components shall be coordinated in advance with Owner and/or Owner's Representative.
- C. The Contractor shall insure that installation personnel understand the requirements of this Specification.
- D. Working Hours
  1. Contractor shall have standard access to the sites from 0800-1700 hours Monday-Friday, unless otherwise specified as determined by the Owner and Prime Contractor.
  2. Contractor shall coordinate scheduling and access with the Owner and/or Owner's Representative.
  3. Contractor shall be required to have all onsite workers wear a lanyard with name-badge identification that includes photo ID.

### 3.2 COORDINATION

- A. General
  1. Coordination with the Owner is critical. Do not interrupt any functioning systems without complying with the requirements of "Notification" section of this specification.
  2. Coordinate the work with the Owner's Representative and all trades to assure that where this work interfaces to other trades, those interfaces are provided, complete and functional.



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3. Verify field conditions. Regularly examine construction and the work of others which may affect the work to ensure proper conditions are provided for the equipment and devices before their manufacture, fabrication, or installation. Be responsible for the proper fitting of the systems, equipment, materials, and devices provided as part of this work.
- B. Project Management: Provide a project manager for the duration of the project to coordinate this Work with other trades. Coordination services, procedures and documentation responsibility include, but are not limited to, the items listed in this section.
- C. Required Resources: Become familiar with the available access and space for equipment and any potential interference requiring coordination. Provide the physical space for equipment, and ample access room for installation and maintenance of equipment.
- D. Positioning Members: Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Owner's Representative without additional expense.
- E. Equipment shall be mounted with sufficient clearance to meet applicable codes and facilitate observation and testing. Securely hang and/or fasten with appropriate fittings to ensure positive grounding, free of ground loops, throughout the entire system. Units shall be installed parallel and square to building lines.
- F. Installation shall comply with "Codes and Standards" section of this specification. Where more than one code or regulation is applicable, the more stringent shall apply.
- G. Where new equipment is replacing old equipment, Contractor is responsible for removing the old equipment and doing repair work necessary to meet standards determined by Owner's Representative.
- H. Install fire stopping for penetrations in slabs and firewalls to meet code at the completion of work and prior to final testing demonstration to Owner's Representative.
- I. Project Documentation: Review project documentation. If the Contractor perceives conflict or ambiguity in the contract documents, he shall seek interpretation from the Owner's Representative. Failure to do so may result in remedial work.
- J. Supervision: Maintain a competent supervisor and supporting technical personnel acceptable to the Owner during the entire installation. A change of supervisor during the project shall not be acceptable without prior written approval from the Owner's Representative.
- K. Project Meetings: Contractor shall attend project progress meetings as stipulated by the Owner or Owner's Representative. Meetings may be held on-site, via Internet, or by phone.



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- L. Work and Manpower Rules: Comply with applicable jobsite work and manpower regulations.
- M. M. Found Conflicts: Continuously make known to the Owner, conflicts discovered which may affect the orderly completion or the specified performance of this work. Cooperate with the Owner's Representative and other trades to accommodate such changes as may be necessary to resolve found conflicts.
- N. Coordination Difficulties: Promptly notify the Owner's Representative in writing of any difficulties which may prevent proper coordination or timely completion of this work. Failure to do so shall constitute acceptance of construction as suitable, to receive this work, except for defects that may develop in the work of others after its execution.
- O. Environmental: Verify the intended location(s) for equipment is suitable for the equipment. If conditions such as temperature, humidity, dust level or the like require modification, make it known to the Owner immediately upon award of the contract. If equipment requires strict environmental conditions (dust limitations, etc.), notify the Owner's Representative immediately upon award of the Contract. Failure to notify the Owner's Representative of such conditions shall constitute acceptance of the conditions and any later required modifications to the equipment or the environment shall be at the sole cost of the Contractor.

### 3.3 WORKMANSHIP

- A. The installation shall be performed in a professional and workmanlike manner.
- B. On a daily basis, clean up and deposit in appropriate containers debris from work performed under the appropriate Specification sections. Stack and organize parts, tools and equipment when not being used.
- C. Preparation, handling, and installation shall be in accordance with the Manufacturer's written instructions and technical data appropriate to the product specified.
- D. Work shall conform to the National Electrical Contractors Association "Standard of Installation" for general installation practice.
- E. At the conclusion of the installation, work areas, including panel boxes, shall be vacuumed, and cleaned to remove debris and grease.

### 3.4 EXAMINATION

- A. Verify that electrical requirements including junction boxes, floor boxes, ceiling loudspeaker enclosures, empty conduit and power circuits and receptacles are in place as shown on the drawings.



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3.5 INSTALLATION

- A. General: Include the delivery, unloading, setting in place, fastening to walls, floors, ceilings, counters, or other structures where required, interconnecting wiring of the system components, equipment alignment and adjustment, and other work, whether or not expressly required, which is necessary to result in complete operational systems.
- B. Physical Installation
  - 1. Firmly secure equipment in place unless requirements of portability dictate otherwise.
  - 2. Provide adequate for fastenings and supports with a safety load factor of at least three.
  - 3. Secure plumb and square boxes, equipment, etc.
  - 4. Install every item so that it not only functions correctly and is serviceable and replaceable, but also looks neat and professional.
- C. Attachment of Devices to Displays and Projectors
  - 1. Attach devices to displays and projects using 3MTM part number TB3571/TB3572 or an approved equal only.
  - 2. Prepare mounting surfaces per the manufacturer's instructions.
  - 3. Where possible, mount devices inset from the sides of displays to minimize their visibility.
  - 4. Mount devices square and plumb.
  - 5. Mount each device such that neither the device's nor the display's cooling is impaired.
- D. Jacks and Connectors
  - 1. Panel-mounted jacks must be recessed and have isolated grounds.
  - 2. Contacts must be silver- or gold-plated over brass.
  - 3. Unless otherwise called for in these specifications and drawings, use the following types of jacks:
    - a. Microphones without mute controls: XLR-3 female
    - b. Microphones with mute controls: XLR-5 female
    - c. Line-level audio: combination XLR-3 or ¼" TRS
    - d. Loudspeaker: Neutrik, Speakon, or Switchcraft equivalent
    - e. Video: BNC
    - f. RF: F
    - g. Camera: Triax or multi-pin bulkhead
    - h. Wired Remote Control (multiplex signal): XLR-5 female
  - 4. i. Wired Remote Control (relay contacts): Neutrik Neutricon
- E. Blank Panels



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1. Provide and install trim and blank plates in all floor, wall and furniture-mounted boxes that incorporate audiovisual connectivity within the assembly, including but not limited to:
  - a. Blank standard ganged plates
  - b. Blank Decora-style plates
  - c. Blank modular (e.g., AAP and MAP) plates and inserts
2. Blank vendor-specific plates and inserts

### 3.6 CUTTING, PAINTING AND PATCHING

- A. Structural members shall not be drilled, bored, or notched in such a manner that shall impair their structural value. Cutting of holes in structural members, if required, shall be done with core drills and only with the specific approval of the Owner for each instance. Provide means to identify rebar in slabs prior to drilling.
- B. Walls and other architectural features that require cutting or repair during the installation process shall be returned to their original condition, including the matching of colors and finishes to the satisfaction of Owner, and at no additional cost to Owner.

### 3.7 GROUNDING PROCEDURES

- A. Provide grounding of systems and equipment in accordance with manufacturer's recommendations, local electrical codes, and industry standards.
- B. Signal Ground: Signal ground shall be derived from the one main electrical panel which serves all equipment herein.
- C. Grounding procedures for wire, equipment and devices shall be in strict accordance with manufacturers' recommendations and standard installation practices.
- D. Contractor shall eliminate or correct potential ground-loop problems in a manner approved by the Engineer.
- E. Cable Shielding: Shielded cables of this section shall be grounded exclusively to Signal Ground. No shields shall be permitted to carry live currents of any kind. Shields shall be tied to Signal Ground at one end only, unless otherwise noted or required by the manufacturer.
- F. Rack Ground
  1. Connect one #6 AWG insulated copper wire connected to the earth ground to the primary system ground busbar in the Equipment Rack.
  2. Bond one #12 AWG TW stranded wire from the Equipment Rack frame to the primary system ground bus bar.



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- G. Equipment Grounds: Grounding methods used will be dependent upon individual equipment interconnection of chassis ground, circuit common, and power supply common within the units. Provide ground method for equipment types as follows:
1. Equipment having a three-wire power cord with green wire of the power cord connected to chassis (Signal common is not internally connected to chassis): Make no connection from chassis ground to primary systems ground bus bar in Equipment Rack.
  2. Equipment having a three-wire power cord with green wire of the power cord connected to chassis: Make no connection from chassis ground to primary system bus bar, but do make connection with 14AWG insulated wire from circuit common to primary system ground busbar in Equipment Rack. Separate circuit common from chassis ground.
  3. Equipment having a two-wire power cord, no green wire, neutral is not tied to chassis, and circuit common is tied to chassis: Make connection from chassis to primary system ground bus bar using 14-gauge insulated wire.

### 3.8 CONDUIT AND WIRE INSTALLATION PRACTICES

A. A. Conduit

1. Conduit shall be 3/4 inch minimum unless noted otherwise on the drawings
2. Wires shall be installed in conduit or in another Owner approved raceway for power and exposed wiring, in areas where mechanical or environmental conditions may damage conductors, and where otherwise specified herein or required by code.
3. Conduit or raceway that is not hidden must have its location and appearance be specifically approved by Owner. If approved, exposed conduit or raceway shall be run in such a fashion as to make it as inconspicuous as possible. Runs should follow existing building lines and should be square wherever possible.
4. Verify conduit has been installed, de-burred and properly joined, routed, and terminated prior to pulling of cables.
5. Apply a chemically inert conduit lubricant to wire and cable prior to pulling. Do not subject wire and cable to tension greater than recommended by the manufacturer.

B. Wiring Without Conduit

1. Wiring may be run in concealed spaces without conduit, in electrical trays, and where otherwise shown on drawings, provided conductors are reasonably protected from mechanical and environmental damage.
2. Conductors run without conduit shall be approved, UL Listed, rated, and labeled for Plenum use.
3. Secure wire and cable with approved supports in accordance with the referenced standards and the Authority Having Jurisdiction.
4. Provide cable supports at a minimum of 4-foot intervals.
5. Secure cables to cabinets, junction boxes, pull boxes and outlet boxes with approved cable clamps.



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6. Independently support cables. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts).
7. Support cable independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
8. Support cable using cable trays, D-brackets, support straps, support wires or other approved cable supports.
9. Fasten cable supports to building structure and surfaces.

C. New Wiring

1. After installation, and before termination, wiring shall be checked and tested to insure there are no grounds, opens, or shorts on any conductors or shields.
2. Run wires continuously from termination to termination without splices.
3. Water-resistant protection shall be continuous throughout the cable in parking areas, surface conduit, poles, in-slab pull-boxes, in-slab conduit, and underground conduit and pull-boxes, and in any areas subject to moisture and/or water infiltration.
  - a. Cable Entries: Provide water-blocking sealants at all conduit entries into pull-boxes, junction boxes, back-boxes, cabinets, etc., to prevent the entry of moisture or water into the conduit and cable system.

D. Wire Lacing and Dressing: Dress, lace, tie or harness wire and cable vertically, horizontally and at right angles to the enclosure surfaces to prevent mechanical stress on electrical connections as required herein and in accordance with accepted professional practice. No wire or cable shall be supported by a connection point.

E. Group cables and wires according to the signals being carried. Form separate groups for the following cables:

1. Power cables
2. Control cables
3. Analog video cables
4. Digital audio and video cables
5. Analog microphone audio cables
6. Analog line audio cables
7. Loudspeaker audio cables
8. RF cables

F. Mark cables, regardless of length, with permanent, non-handwritten number or letter cable markers per the instructions below in Labeling. There shall be no unmarked cables in the system.

G. Furnish screw-type terminal blocks, boards, strips, or connectors, for cables which interface with racks, cabinets, consoles, or equipment modules. Terminate wires terminating at screw-type terminals with crimp-on lugs. "Telephone-style" punch-down blocks are not acceptable for signal and data wiring.



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- H. As a general practice, run power cables, control cables, and high-level cables on the left side of an equipment rack as viewed from the rear. Run other cables on the right side of an equipment rack, as viewed from the rear. Where wiring issues preclude this orientation, it is acceptable to deviate from the directions above, as long as separation is maintained between signal and electrical power cables.
- I. Provide a service loop of appropriate length within racks and at boxes or points of termination to allow each piece of equipment to be removed from the front of the rack for servicing. Provide service loops at boxes or points of termination to allow the equipment to be removed and laid flat on a surface for servicing.
- J. Install no cable with a bend radius less than that recommended by the cable manufacturer.
- K. Clearly identify cable terminated in a floor pocket with permanent, indelible, computer or label printer labels within 6" of the cable connectors. Provide strain relief for cables. Provide a minimum of 3' of free cable coiled in the floor pocket. Use nylon cable ties to group similar cable types.
- L. Unacceptable Conditions: Correct any unacceptable wiring conditions immediately upon discovery, and upon receiving notice to correct.

### 3.9 PROGRAMMING

- A. Touch Panel/Control System
  - 1. Initial menu screen (splash screen) shall use a version of the Owner's logo generated without visible scaling artifacts for the size of the screen.
  - 2. Red shall only be used for alarm indicators and other buttons and indicators of special significance.
  - 3. Avoid all use of technical terms; use clear, everyday language. Instead of "System On", for example, use "Turn System On"; instead of "Power Down", use "Turn Power Off", etc.
  - 4. Ensure items with similar functions appear consistently in all menus.
  - 5. Ensure all buttons are sized similarly and spaced evenly.
  - 6. Ensure spelling is 100% correct.
  - 7. Menus throughout the project should appear and function consistently, across all touch panels and control system web pages.
  - 8. Provide audible feedback for button presses; provide a volume control for this feedback in a tech menu.
  - 9. Provide a tech menu for each touch panel. The tech menu shall offer control of button feedback volume, screen brightness, and other technician-specific functions required for each system.
    - a. Provide in the tech screen a means to change the tech screen password.
    - b. Obtain from the Owner's Representative a default password for all touch panel tech menus.



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10. Provide web access for all IP-enabled control systems. Via IP, users and/or technicians shall be able to operate all functions provided via touch and pushbutton panels. Coordinate with the Owner's Representative to ensure a successful implementation of this requirement.
  11. Owner to provide control panel template.
- B. Projectors and other devices with frequent need for the replacement of consumables shall use the computer network for preventative maintenance.
1. Coordinate with the Owner's Representative to obtain the default email address for maintenance messages.
  2. Ensure Owner's Representative can revise the maintenance email address via a simple method – using a single address for all networked AV devices. Contractor shall document this procedure in the Operations Manual.
- C. Power Control and Sequencing
1. Provide power control interfaces for devices not provided with these, whether these accessories are listed in this Section or not. Specify accessories compatible with the specified control products.
  2. Ensure that all non-essential items are turned off or placed in a low power consumption operation mode when system is turned off. At minimum, program the AV system to turn off the following types of devices when it is not in use.
    - a. Audio amplifiers
    - b. Audio processors
    - c. Video switchers and processors
    - d. Displays
    - e. Projectors
  3. Sequence power on and power off cycles to ensure these take place with no audible and only minimally visible artifacts, pops, etc. When turning systems on, use the following sequence.
    - a. Turn on source devices.
    - b. Turn on processing and routing devices.
    - c. Turn on amplifiers, displays and projectors.
    - d. When turning systems off, use the following sequence.
    - e. Turn off amplifiers, displays and projectors.
    - f. Turn off processing and routing devices.
    - g. Turn off source devices.
- D. Analog audio: Program each device and any system components involved so the analog audio input is active regardless of which video input is selected.
- E. Divisible spaces: Using the rooms' partition sensors, automate audiovisual system combine/divide functions in AV-equipped rooms with operable partitions.
- F. Lighting System Programming and Interface Coordination
1. 1. Lighting Designer Responsibilities



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- a. Via coordination with the project lighting designer, determine lighting scenes for each area with a low voltage-controlled lighting system
  - b. For rooms with projection systems, provide a presentation-type scene that turns off any lights illuminating projection screens
  - c. Assign a short name for each lighting scene. Coordinate with the AV control system programmer to determine maximum scene name length.
  - d. Provide these names to the design team
2. Lighting System Installer and Programmer Responsibilities
- a. Program lighting scenes per the lighting designer's list into the rooms' lighting systems
  - b. Provide appropriate control protocol/preset information to AV control system programmer
  - c. Coordinate with the AV control system programmer for hardware interface requirements between AV control systems and lighting systems
  - d. Coordinate with GC to determine where lighting control cabling will run and who runs it
  - e. Coordinate with the AV control system programmer for lighting system testing and fine-tuning
3. AV Control System Programmer Responsibilities
- a. Program lighting scenes provided by the lighting designer into the appropriate control system menus. Use the provided scene names.
  - b. Coordinate with the lighting system designer and GC for control cabling and termination, etc.
  - c. Coordinate with the lighting system designer for testing and fine-tuning
  - d. Train users in the use of appropriate lighting scenes ("Presentation" during projection, etc.)

### 3.10 EQUIPMENT COOLING

- 1. Utilize thermostatically controlled active cooling devices if necessary, to keep device temperatures below manufacturer-specified maximums. Systems including devices operating above manufacturer-specified limits shall be rejected. Cooling systems utilizing fans running continuously, without thermostatic controls, will be rejected.

### 3.11 FIRMWARE & SOFTWARE UPGRADES

- A. If more recent versions of the operating system, firmware and application software are made available to or requested by the Owner prior to system acceptance, these updated versions shall be installed and verified by Contractor.
- B. Before installing firmware and software upgrades, Contractor shall ensure that existing information is properly "backed-up" prior to any installation action.



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3.12 START-UP RESPONSIBILITY

- A. Properly ground each piece of electronic equipment prior to applying power.
- B. Properly ground all shielded wire shields to the appropriate earth ground at the hub end only, not at the remote or device end.
- C. Use a start-up sequence that incrementally brings each portion of the system on-line in a logical order that incorporates checking individual elements before proceeding to subsequent elements until the entire system is operational.

3.13 PRELIMINARY INSPECTION AND TESTING

A. General

- 1. Furnish labor, instruments, products, and sufficient materials required for testing at each test.
- 2. Correct deficiencies found as a result of tests and make replacements or repairs to tested products that are damaged as the result of the tests.
- 3. Schedule tests at a time convenient to witnesses thereto or persons affected by the tests.
- 4. Provide fourteen (14) day written notification to the Owner for test procedures prior to the test.
- 5. Make records of all tests in a neat and legible form. Identify the equipment or system tested and the test data.
- 6. Check control, instrumentation, and power cables and conductors for proper connections, workmanship, and identification.
- 7. Submit to the Owner certified reports on all tests indicating full compliance with test requirements.

B. Testing Audiovisual Systems

- 1. Testing Report shall include the following:
  - a. Tests Failures and Notices
  - b. Sink Device EDID Test – Open items or failures shall not be accepted.
  - c. Cable Length Test - Open items or failures shall not be accepted.
  - d. HDCP KSV Limitations – Limitations shall not be accepted.
  - e. Cable Limitations – Limitations shall not be accepted.
  - f. EDID Limitations – Limitations shall not be accepted.
  - g. Cable Length Limits exceeded – Failing cables shall not be accepted.
- 2. Device Model Number, Serial Number, and Firmware Version for main chassis and each input and output card.
- 3. Device Model Number, Serial Number, and Firmware Version for connected transmitter and receiver devices.
- 4. EDID – Input Resolution and 3D support status for each input.
- 5. EDID – Supported Output Resolution and 3D support status for devices connected to each output.



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6. EDID – Supported Audio formats for each input.
7. EDID – Supported Audio formats for devices connected to each output.

3.14 SYSTEM PERFORMANCE TESTING AND ADJUSTING PROCEDURES

- A. Provide performance testing and adjusting of systems and equipment in accordance with ANSI/INFOCOMM 10:2013 Audiovisual Systems Performance Verification Standard.

3.15 ACCEPTANCE TESTING AND ADJUSTMENT PROCEDURES

- A. Purpose: Conduct testing and adjusting procedures to realize and verify the performance criteria specified herein and identified in Preliminary Testing procedures listed above. Successfully demonstrate the acceptable performance of each specified system in the presence of the Owner and Engineer.
- B. Scope: Conduct all performance testing, adjustment, and documentation procedures to verify and realize compliance with the performance specifications herein. Make available at least one (1) engineer familiar with this work, and all required test equipment for the duration of performance testing verification, at the convenience of the Owner.
- C. Acceptance Testing Readiness: Acceptance testing will be performed after the system is installed and pre-tested completely.
  1. The contractor shall have successfully tested the system prior to scheduling formal acceptance testing. Contractor shall correct any and all deficiencies found at this time.
  2. Acceptance testing will be conducted in accordance with the approved Acceptance Testing Plan with a minimum of testing listed in Preliminary Testing section.
- D. Acceptance Testing Schedule: Contractor shall confirm in writing to the Owner's Representative when the system is ready for acceptance testing. Contractor shall then schedule a complete Acceptance Test at the convenience of the Owner.
- E. Acceptance Testing
  1. Contractor shall test and verify the performance of all equipment, systems, interfaces, and peripheral equipment in the presence of the Owner's Representative and/or Engineer(s).
  2. Tests shall be performed in accordance with the requirements of individual systems as specified herein and in related specification sections. Test shall incorporate testing described in preliminary inspection and testing.
  3. Contractor shall furnish testing forms for each AV system.



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- F. An Observation Report will be generated by the reviewing team, Owner representative, Design Engineer and Contractor for contractor to review.
- G. Correction of Jobsite Observation Report Items: Perform any and all remedial work to correct inadequate performance or unacceptable conditions of, or relating to any of this work, as determined by the Owner within ten (10) working days of the completion date. Corrective work shall be performed at no additional cost to the Owner. Contractor shall provide a written report each week of repairs made and plan to complete repairs in progress.
- H. Test Documentation: Document all acceptance testing, calibration and correction procedures described herein with the following information:
1. Performance date of the procedure
  2. The names of personnel conducting the procedure
  3. The equipment used to conduct the procedure
  4. Type of procedure and description
  5. Condition during performance of procedure
  6. Parameters measured and their values, including values measured prior to calibration or correction as applicable.
- I. Tests and Measurements: Before final adjustment and acceptance tests are scheduled, perform system checkout. Furnish required test equipment and perform work necessary to determine and/or modify performance of the system to meet the requirements of this specification. Include the following:
1. Adjust, balance, and align equipment for optimum quality and to meet the manufacturers' published specifications.
  2. Perform the test procedure provided with this specification and return the completed form no less than one week prior to the initial punch walk.
  3. Install 1/8" diameter vinyl "map dots" as indicators for nominal operating positions of rotary, slider, or switch controls available for operator adjustment. Provide multiple indicators, adequately distinguished, for controls having more than one nominal operating position.
- J. Twisted-Pair Cabling Infrastructure: If audiovisual system includes twisted pair cabling infrastructure, test the twisted pair cabling using the following procedure.
- K. Required Equipment:
1. Fluke DTX-1800 or equal
  2. Test Procedure:
    - a. Test each cable using the CAT6 Channel test
    - b. Ensure that each cable passes the test. Re-terminate or replace all cables that do not pass.
- K. Digital Video Cabling: Follow the following procedure to test each provided digital video cable.
- 1) HDMI:
    - a) Required Equipment:
    - b) Quantum Data 780 2)



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- c) Or approved substitute tester
- 2) DVI/SDI/HD-SDI:
  - a) Required Equipment:
  - b) Quantum Data 882D
  - c) Or approved substitute tester
- 3) DisplayPort:
  - a) Required Equipment:
  - b) Quantum Data 882E-DP
  - c) Test Procedure:
  - d) Test each cable.
  - e) Discard all cables that fail

L. Audio System:

1. Loudspeaker-Line Impedance: Measure the impedance at 63 Hz, 250 Hz, and 1 kHz and the resistance of each loudspeaker line leaving the sound equipment rack with the line disconnected from its normal driving source. For lines to full-range distributed loudspeaker systems, measure the magnitude of impedance at 1 kHz.
2. Hum and Noise Level: a. Measure the hum and noise levels of the overall system for each microphone input channel and line level input channel. b. Adjust gain controls for optimum signal-to-noise ratio so that full amplifier output will be achieved with 0 dBm at a line-level input. c. Terminate line-level inputs with shielded resistors of 150 and 600 ohms, respectively, for these measurements. d. Disconnect the loudspeaker lines and terminate the power-amplifier outputs with power resistors for these measurements. The value of the load resistor shall be within 5% of the nominal load impedance of the amplifier under test. The power rating of the resistor shall equal the power rating of the amplifier.
3. System Frequency Response:
  - a. Measure the frequency response using the audio systems as described in Part 1. Adjust gain controls and equalizers to provide the octave-band sound levels as specified.
  - b. Programmable Equalizers: Provide necessary controller with full audio spectrum display for the adjustment of programmable equalizers during system checkout. Do not provide equalizer programmers with the systems.
  - c. Measure octave band of pink noise test signal, centered at 4 kHz, played through loudspeaker system.
4. Power-Output and Signal-Level Adjustment within System:
  - a. Measure the electrical distortion of the overall system for each line-level input channel.
  - b. Adjust gain control as for the tests specified herein.
  - c. Apply a 1-kHz sine wave signal from an oscillator having less than 0.5% total harmonic distortion at the input tested, at a level required to produce full amplifier output. Note that a pad with 150-ohm output impedance is required for driving the microphone-level input in accordance with the EIA standard.
  - d. Use a distortion analyzer to measure the output level and the total harmonic distortion of the amplification and control equipment. In the absence of a



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distortion analyzer, a high input impedance measuring device such as a DMM may be used to measure the output level. Lack of clipping or apparent deformation of a sine-wave input signal at the power amplifier output, as seen on the oscilloscope, may serve as evidence that distortion of amplification and control equipment is within acceptable limits. e. Make measurements with loads actually incurred in the system operation. Power-amplifier loads shall be power resistors equal to the nominal load impedance of the output terminals used in the system.

5. Loudspeaker Polarity
  - a. Perform polarity checks of loudspeaker lines by means of a polarity tester or use DC source at one end of each line and a voltmeter at the other end. Loudspeaker lines shall be identically polarized with respect to color coding.
  - b. Test polarity of the loudspeakers using a sine-wave test signal warbled about 500 Hz. The listener shall be located on axis of the loudspeaker. Switch the loudspeakers from nominally in polarity to nominally out of polarity with respect to the selected loudspeaker. With the loudspeakers in proper polarity, the quality and clarity of the music or speech should be greater, and the warble test signal should clearly come to the surrounding space from the loudspeaker.
6. Freedom from Parasitic Oscillation and Radio-Frequency Pickup:
  - a. With systems set up for each mode of operation specified in the functional requirements, check to ensure that systems are free from spurious oscillation and radio-frequency pickup, in the absence of audio input signal and when the system is driven to full output at 100 Hz.
  - b. Employ an oscilloscope having at least 5 MHZ bandwidth for these checks.
  - c. Apply slow sinewave sweep from 50 Hz to 5 kHz at a level of 6 dB below rated power-amplifier output voltage to each system. Listen carefully for buzzes, rattles, and objectionable distortion.
  - d. Correct causes of these defects unless the cause is clearly from other than the sound amplification system's equipment and installation, in which case bring the cause to the attention of the Owner and Architect.
7. Audio Test Signal Paths: Verify operation from source inputs through system components to signal destinations.

M. Analog Composite Video System:

1. Input Signal Level: Measure standard composite signal level with an oscilloscope across standard input impedance. Signal level shall be 1.0-volt peak-to-peak. Make system adjustments to attain required signal level.
2. Signal-to-Noise: Operate system at standard input and output levels. Terminate with standard load impedance. Measure noise level using oscilloscope for signals from 10 kHz to 4.2 MHZ and an RMS voltmeter for signals from 0 to 10 kHz and calculate signal-to-noise ratio.
3. Differential Gain: Using a step generator and waveform monitor measure chrominance, luminance, and normal synchronizing and blanking signals.



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Measure variation in amplitude of the chroma sub-carrier at 10%, 50%, and 90% luminance.

4. Differential Phase: Operate system as defined above and measure variation in phase of the chroma subcarrier at 10%, 50%, and 90% luminance.

N. Optical System:

1. The light intensity shall be measured at five positions of the projected image (center and four corners) after the projector has been adjusted to provide the light output as specified above.
2. The "corner" locations shall be defined as the four points determined by intersecting lines drawn 5% of the distance in from the focused edges of the image
3. The light meter used for the above measurements shall be a properly calibrated foot-candle (or lux) meter and shall be cosine-corrected.

O. Control System:

1. Verify operational functions at each control interface position.
2. Verify operational functions of wireless control device.
3. operational functions of the control system and interfaced devices.

P. Radio Frequency (RF) System:

1. Use a standard television receiver connected to each system outlet. Make a subjective evaluation of picture quality and verify that no visible components of cross modulation, ghosting, or beat interference appear when the receiver is tuned to each of the desired channels.
2. Using an RF signal strength meter, record the signal levels in dBmV of modulated carriers transmitted through the system at representative outlets.
3. RF Test Signal Paths: Verify proper operation of the system from source inputs to the head end, including antennas, CATV feeds, and modulators, through line amplifiers, splitters, and directional couplers, to system outlets.

### 3.16 LABELING REQUIREMENTS

A. General Requirements

1. Equipment Enclosures
2. Rack-mounted AV Devices
3. Portable AV Devices
4. Batteries
5. Wires and Cables
6. Equipment Racks
7. Terminal Blocks
8. Relays
9. Patch panels, and the termination positions within the patch panels
10. Provide labels that are consistent with the AV documentation.



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11. Prior to installation, degrease and clean surfaces to receive nameplates and labels

B. Equipment Enclosures

1. Label each rack and cabinet with a designation corresponding to the system documentation.
2. Mount the label on the top of the rack or cabinet, centered horizontally.
3. Color: Black background with white lettering.
4. Use ½" high letters a. Example: AV-01

C. Audiovisual Devices

1. Label rack mounted devices associated with AV systems with a permanent, machine-generated, laminated label. Use 12-point black Helvetica text with a white background.

D. Batteries 1. Label batteries with the month and year they were installed.

1. Example: April 2004

E. Wireless Transmitters and Receivers 1. Label wireless transmitters and receivers, including, but not limited to wireless microphone systems clearly so users can identify the transmitter associated with each receiver.

1. Use an identifier that associates each transmitter with the room it is associated with, such as a room number.
2. Example: Rm. 230-Mic 1

F. Wire and Cable

1. Identify wire and cable clearly with permanent machine-generated labels wrapped about the full circumference within one-inch (25mm) of each connection.
2. Indicate the cable ID designated on the associated field or shop drawings and run list.
3. Assign wire or cable designations consistently throughout a given system, i.e., each wire or cable must carry the same number at both ends.
4. Position labels so they are clearly visible without the need to remove wire management devices or other obstructions.
5. At each end of the cable, indicate the device and connector the cable connects to.
6. Example: AV 3101 Mtrx Swx In-1

G. Terminal Blocks

1. Label consistently with each block's designation in the AV documentation.

H. Relays and Transformers



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1. Label consistently with each relay's and transformer's designation in the AV documentation.

I. Patch Panels

1. Using two-line designations, indicate groups of inputs and outputs on the upper row of top ports and the lower row of bottom ports.
2. Example: Mixer Mic Inputs In-1 | In-2 | In-3 | In-4, etc.

J. Initial Testing and Tuning Report.

1. Use additional pages as necessary to allow complete comments.

K. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the Owner or Owner's representative.

1. If the need for further adjustments becomes evident during the demonstration and testing, continue work until the installation operates properly. Included in the continued work shall include, but not be limited to, changes to or installation of resistive pads, adjustment of loudspeaker aiming, adjustment of system processing, programming changes to the control system, convergence and/or alignment of the video projector, if these adjustments are required. If acceptance of the system is delayed because of defective equipment or because the equipment does not fulfill this specification, reimburse the Owner for time and expenses for these tests during extensions of the acceptance-testing period

3.17 COMMISSIONING AND VALIDATION

- A. Commissioning is a "fine tuning" process used for complex systems that occurs after acceptance testing and before final acceptance. It helps assure that the system performs to its fullest potential and validates the effectiveness of the total system. Commissioning should take place prior to the Owner's first use.
- B. This process includes participation by the Owner, Contractor, and the Consulting Engineer. A third-party testing agent may also be hired by the Owner to plan, conduct, and verify the Commissioning process.
- C. The Contractor shall include a minimum of sixteen (16) hours of participation in the commissioning and validation process by a minimum of two (2) employees familiar with the specific project and installation.
- D. Scheduling of Commissioning and Validation testing will be by the Owner, and may occur after the Notice of Completion, but before the end of the Warranty period.
- E. Revisions to the configuration and programming of the system which are recommended by the Commissioning Team as a result of validation testing, shall be performed by the Contractor under the direction of the Owner, at no additional charge.



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The Warranty provisions of this specification shall apply to any configuration and programming revisions resulting from the validation testing process.

- F. Revisions and improvements recommended by the Commissioning Team which require physical modifications or additions to the approved and accepted system, including the provision or relocation of new equipment, wiring, and installation, shall be treated as additional changes to the contract, and shall be processed as defined in the Project General Provisions. Where such requested work was part of the Contractors' original scope of work, as defined in the design drawings and specifications, or in contract revisions and agreements, the Contractor shall provide the work at no additional charge.

3.18 FINAL PROCEDURES

- A. Perform final procedures in accordance with Section 27 00 00.

3.19 NOTICE OF COMPLETION

- A. When the performance and acceptance requirements described above, including the Final Acceptance Test, have been satisfactorily completed, the Owner shall issue a Letter of Completion to Contractor indicating the date of such completion. The Notice of Completion shall be recorded by Contractor upon receipt of the Owner completion letter. This date of record shall be the start of the warranty period.

3.20 FIELD QUALITY CONTROL

- A. Testing
  - 1. All devices shall be tested for full operational compliance.
  - 2. Testing of system shall be the sole responsibility of the Contractor.

3.21 LABELING

- A. Label all cables at each end of each cable. Labels shall be machine generated, wrap-around type.
- B. Labeling system shall designate the cable's origin and destination on each end of each distribution/horizontal cable.

3.22 WARRANTY

- A. All equipment, components, etc., shall be guaranteed free of defects and any faulty workmanship for a period of one year after final acceptance.



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- B. The Contractor shall replace defective materials and repair faulty workmanship within 24 hours of discovery at no cost to the Owner.

**END OF SECTION 27 41 16**



## **SECTION 28 00 00 - ELECTRONIC SECURITY**

### **PART 1 - GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Applicable requirements of Division 01 - General Requirements shall be considered a part of this section and shall have the same force as if printed herein full.

#### **1.2 QUALITY ASSURANCE**

- A. Specifications, Standards and Codes: All work shall be in accordance with the following:
  - 1. The 2016 edition of the National Electrical Code (NFPA 70).
  - 2. American National Standards Institute (ANSI).
  - 3. National Electrical Manufacturers Association (NEMA)
  - 4. Telecommunications Industries Association (TIA)
  - 5. Institute of Electrical & Electronics Engineers (IEEE)
  - 6. Underwriters Laboratories (UL)
  - 7. American Standards Association (ASA)
  - 8. Federal Communications Commission (FCC)
  - 9. Occupational Safety and Health Administration (OSHA)
  - 10. American Society of Testing Material (ASTM)
  - 11. Americans with Disabilities Act (ADA)
  - 12. Local city and county ordinances governing electrical work.
  - 13. In the event of conflicts, the more stringent provisions shall apply.

#### **1.3 SCOPE**

- A. The work to be done under this section of the Specifications shall include the furnishing of labor, material, equipment and tools required for the complete installation of the work indicated on the Drawings or as specified herein.
- B. All materials, obviously a part of the Electronic Security Infrastructure and necessary to its proper operation, but not specifically mentioned or shown on the Drawings, shall be furnished and installed without additional charge.
- C. The Drawings and Specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the Drawing and Specifications, the higher cost shall be included, and the engineer shall be notified of the discrepancy.



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D. Systems: Provide a Video Surveillance System (VSS) system Intrusion Detection System (IDS) Security system, and i an Electronic Access Control System (ACS) complete per the contract schedule, and with acceptable engineering and installation practices as described herein.

1. Areas of work include, but are not limited to:
  - a. Security Operations Center
  - b. Shop Engineering and Documentation
  - c. Wiring and Installation Diagrams
  - d. Submittals
  - e. Coordination
  - f. System Installation
  - g. System Integration
  - h. Training
  - i. Start-up Testing
  - j. Commissioning
  - k. Close out As-Build documentation
  - l. Warranty

#### 1.4 BID RESPONSE

##### A. Bidders Responsibility

1. Contractor is responsible for verifying actual conditions by visiting the site, reviewing the Specifications and drawings, and to advise the Owner in writing of any conditions which may adversely affect the work. If any necessary exceptions are discovered, Contractor shall immediately notify the Owner for resolution prior to any change in the design or the scope, and any resultant claim for additional compensation.
2. The Bid Response must fulfill the intent of the Drawings and Specifications to the satisfaction of the Owner to qualify as an acceptable Bid Response.

##### B. Substitutions

1. Catalog and/or model numbers for Owner approved equipment and systems are included as a part of these specifications.
2. Any substitution proposed by Contractor for catalog numbers and brands or trade names noted or specified herein shall be solely at the Contractors risk. The Owner maintains sole authority to hold a review of substitutions, and sole authority to approve or disapprove of substitutions for any reason.
3. The Owner's acceptance of substitutions shall not relieve Contractor from complying with the requirements of the drawings and Specifications. Contractor shall be responsible, at Contractor's sole expense, for any changes resulting from Contractor's substitutions that affect other parts of Contractor's own work or the work of others.

C. Technical Bid Submission: At bid submission, submit one (1) copy of the following:



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1. An equipment list with names of Manufacturers of primary systems (VSS & IDS & ACS) including model numbers and technical information on equipment proposed
2. A letter from the manufacturer(s) stating that the system Contractor is an authorized distributor or installer of the proposed primary systems (VSS, IDS, ACS).
3. Indicate complete and total compliance with the provisions of these Specifications by letter or by submittal of the bid response forms, signed by an officer of the corporation, or a principal if other ownership currently exists. If there are exceptions to the specifications, submit a statement listing every technical and operational parameter wherein the submitted equipment or system may vary from that which was originally specified. If the submitter fails to list a particular variance and his submittal is accepted, but is subsequently deemed to be unsatisfactory because of the unlisted variance, the submitter must replace or modify such equipment at once and without cost to the Owner.
4. Failure of Contractor to submit the above information shall be considered non-responsive to the bid requirements and sufficient cause for bid rejection.

D. Examination of Site and Verification of Existing Conditions

1. Contractor shall have visited the site and familiarized himself with existing conditions prior to submitting his bid and shall be prepared to carry out the work within the existing limitations. Failure or neglect to do so shall not relieve Contractor of his responsibilities nor entitle him to additional compensation for work overlooked and not included in his bid.
2. Existing structures and utilities shown on the contract drawings are obtained from project drawings and exploratory field examination. Contractor shall verify existing conditions and required dimensions, including those shown on the drawings, by measurement at the job site. Contractor shall notify the Owner of exceptions before proceeding with the work.
3. Contractor shall confirm the availability of the proper power source for each piece of specified equipment, through site visits and drawings as necessary. Where proper power does not exist, Contractor shall identify this situation to the Owner for guidance. Should the Owner direct Contractor to provide the necessary power, it shall be provided using equipment and methods authorized by the Owner.

- E. Data Accuracy: Absolute accuracy of information regarding existing conditions cannot be guaranteed. The Drawings and Specifications are for the assistance and guidance of Contractor and exact locations, distances, and elevations will be governed by actual field conditions. Where variations from the bid documents are required, such variations shall be approved by the Owner.

1.5 QUALIFICATIONS

A. General

1. The approved Contractor shall be responsible for satisfactory operation of the system and its certification.



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2. Approval of the Owner is required of products or services of the proposed manufacturer, suppliers and installers and will be based upon conformance to the specifications.

B. Manufacturer Qualifications

1. System components shall be furnished by manufacturers of established reputation and experience who shall have produced similar equipment and who shall be able to refer to similar installations rendering satisfactory service.
2. The manufacturer's products shall have been in satisfactory operation on at least three similar installations for not less than three years. Contractor shall submit a list of similar installations.
3. Components including, but not limited to, card access controllers, cameras, intercoms, computers, and power supplies shall have been tested and listed by Underwriters Laboratories, Inc., Factory Mutual Systems, or other approved independent testing laboratory.
4. Components installed within a common enclosure shall be approved by an agency recognized by the local city Department of Building and Safety as an assembly.

C. Contractor Qualifications

1. Hold current legally required California State Contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. Contractor shall submit copies of licenses to Owner prior to the start of work.
2. Hold current legally required state registrations required to meet local requirements for submittal drawings
3. Have manufacturers trained and certified engineering, field technicians and programming staff.
4. Indicate complete and total compliance with the provisions of these Specifications by letter or by submittal of the bid response forms, signed by an officer of the corporation, or a principal if other ownership exists. In addition, the letter or forms shall include a complete listing of exceptions, if any.

1.6 PHASING PLAN

A. The work shall be performed in phases.

1. Each phase of work shall include, but not be limited to the provision of applicable conduit, power, equipment, programming, and documentation to provide a complete, operational system, as described herein.
2. Coordinate work phasing with the Owner
3. Within 14 days after award of the project, submit a preliminary phasing plan to the Owner for review. The Shop Drawings shall reflect the process of the phasing plan.



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- B. The Phasing Plan shall be designed to allow the continuation of business and activities, to support uninterrupted electronic Access Control services, where possible, and to limit down- time of critical systems, during construction. Each system element shall be addressed individually. Phases and system elements may be combined, or rearranged, based upon planned work schedules and available labor to perform the work.
- C. Work which requires shut-down of, or any part, of the Security systems shall be scheduled and performed between the hours of 11:30 PM to 5:30 AM unless written approval for alternate time is provided by the Owner.
- D. Phasing Plan: The proposed phasing plan should address the upgrades with the following approach:
  - 1. Install or coordinate with the Owner on the installation of the required network connectivity.
  - 2. Install, power, and test the control equipment, including but not limited to video recorders, computer workstations, and application software. Where new equipment will replace existing equipment in the same location, provide temporary installation of the new equipment.
  - 3. Install conduit, cable, and new devices. Connect to controls, and test.
  - 4. Install conduit, cable, and devices which replace existing devices. Connect to controls, and test.
  - 5. Where new equipment replaces existing equipment in the same location, remove existing and install the new equipment. Reconnect pre-tested devices, and test again.
  - 6. Program, configure, test and commission the system as required by the Owner and these specifications.
- E. Modifications to the Phasing plan may be submitted by the Contractor, after the Shop Drawings and Equipment Submittals have been reviewed and accepted for installation. The Contractors' modified phasing plan shall be based upon Contractor's actual proposed equipment, project schedule and installation planning. The proposed phasing plan shall be designed to achieve the same goals as the phasing plan contained herein, including but not limited to, the successful upgrade of existing systems while maintaining full control at the facility. The Contractors' plan must be accepted by the Owner prior to any demolition or installation of equipment and cable. The Owner reserves the right to modify the proposed plan, or any part thereof.

## 1.7 RELATED WORK

- A. General
  - 1. Observe interface procedures to related work.
  - 2. Coordinate with the Owner on aspects of aesthetic interface.
  - 3. Coordination: Coordinate this work with related work by other contractors.
  - 4. Coordinate with existing construction, equipment, and field devices.



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5. Equipment provided under this project shall be installed in a manner consistent with architectural, operational, service and maintenance considerations.
  6. "Coordinate" related work not specifically mentioned below.
- B. Owner's General Provisions and Work Contract
- C. Division 01, General Requirements: Coordinate this work with applicable sections of the Owner's General Requirements and General Provisions.
- D. Finishes: Coordinate this work with applicable Owner requirements for Finishes, including but not limited to the following.
1. Painting/Patching: Provide painting, patching and repair services to match existing conditions.
  2. Painting of walls shall be from corner of nearest wall across repair area to nearest wall on opposite side of repair area.
- E. Division 26, Electrical
1. Coordinate this work with applicable sections of Division 26, Electrical, including but not limited to the following:
    - a. Electrical power distribution sources for existing buildings shall be by the Owner unless otherwise noted. Contractor shall coordinate with the Owner to identify and verify 120-volt power service requirements with the first shop drawing submittal.
    - b. Conduit, boxes, and rough-in material shall be provided and installed by the Contractor, unless otherwise noted.
    - c. Specialty boxes shall be provided by the Contractor and installed by the Contractor, unless otherwise noted.
- F. Division 27, Communications
1. General: Coordinate this work with applicable sections of Division 27, Communications, including but not limited to structured cabling, fiber optic cabling, telephone, and data communications requirements.
  2. Contractor shall coordinate with the Owner to identify and verify shared cable/pathway, LAN ports, and bandwidth requirements at the time of the first shop drawing submittal.
- G. Division 28, Electronic Safety, and Access Control
1. Existing Systems: Coordinate with Owner and Owner's existing Service Provider to ensure the existing system(s) are kept in active operation during the course of this project, in keeping with appropriate phases of work. Coordination may require reconfiguration and reprogramming of existing controllers and other system elements. This work will be coordinated by the Contractor, and provided by the Owner or an Owner- selected Service Provider.
  2. Section 28 08 00 – Security Testing and Commissioning



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- a. Provide equipment and services required by related Sections pursuant to the requirements of Section 28 08 00, Testing and Commissioning.
- 3. Section 28 16 00 – Electronic Intrusion Detection System
  - a. Provide equipment and services required by Section 28 16 00, Intrusion Detection System, pursuant to the requirements of this section.
- 4. Section 28 23 00 - Video Surveillance System
  - a. Provide equipment and services required by Section 28 23 00, Video Surveillance System, pursuant to the requirements of this section.

1.8 PRECEDENCE

- A. If any statement in this or any other Security specification is in conflict with any provision of the General Terms and Conditions of the contract, the provision stated in the General Terms and Conditions shall take precedence. Any questions that result from such potential conflict, which require additional interpretation and guidance shall be immediately brought to the Owner's attention.
- B. Obtain, read and comply with Division 26, Electrical and applicable sub-sections of the contract specifications. Where a discrepancy may exist between any applicable Division 26 sub-sections and directions as contained herein, this section shall govern.
- C. Architectural drawings shall have precedence over other drawings in regard to dimensions and location.

1.9 APPLICABLE PUBLICATIONS

- A. The edition of the appropriate code or standard at the time of permitting shall govern all applications.
- B. Standards: Perform the work in accordance with the following standards:
  - 1. UL Underwriters Laboratories, Inc., UL 294, UL 1076, ULC
  - 2. NTSC National Television Standards Committee.
  - 3. NEMA National Electrical Manufacturers Association.
  - 4. NECA National Electrical Contractor's Association, Standards of Installation.
  - 5. NFPA National Fire Protection Association 101 Life Safety Code
  - 6. CCR Title 24 California Building Code
  - 7. CCR Title 24 California Electric Code
  - 8. ADA Americans with Disabilities Act
  - 9. FCC Part 15, Part 68
  - 10. IEEE RS 170 variable standard NTSC (color camera broadcast)
- C. Where more than one code or regulation is applicable, the more stringent shall apply.



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- D. Cable installation, identification and termination shall be performed in accordance with manufacturer's installation manuals in addition to the above applicable codes.
- E. In the absence of manufacturer's recommendations on conductor applications, the Contractor shall ensure that the cable selected meets all technical requirements of the location of its installation, and of the equipment to be installed.

1.10 SHOP DRAWING & EQUIPMENT SUBMITTAL

- A. General: Bid documents, including drawings, details and specifications are considered conceptual in nature, and provide direction on products and project requirements. Contractor is given a choice of methods that may be incorporated into the system. These choices may affect the overall design, configuration, and installation of the proposed system.
- B. Contractor Responsibility: Prepare and submit shop drawings, rendered in the latest AutoCad or Revit format, which show details of all work to insure proper installation of the work using those materials and equipment specified or allowed under the approved plans and specifications. A complete Shop Drawing submittal package shall consist of Drawings, Equipment Data Sheet Submittals, and an Acceptance Testing Plan.
- C. Completeness: The Equipment Submittals, Acceptance Testing Plan and the Shop Drawings should be submitted as a complete and contiguous package. Partial or unmarked submittals will not be accepted for review.
- D. Scheduling: A schedule of shop drawing submissions shall be submitted for the Owner's review on a form acceptable to the Owner within ten (10) days after award of the Contract. The schedule of shop drawing submissions shall include as a minimum, but not limited to the requirements stated herein.
- E. Requirements: Provide the following information complete, and in the manner described herein:
  - 1. Hardware, Application Software, and Network Requirements: A system description including analysis and calculations used in sizing equipment required by the security systems. The description shall show how the equipment will operate as a system to meet the performance requirements of the systems. The following information shall be supplied as a minimum:
    - a. Server(s) processor(s), disk space and memory size and/or expansion of existing
    - b. Workstation(s) processor(s), disk space and memory size
    - c. Description of site (field) control equipment (Controllers/Field Panels, NVR's, Modules) and their configuration
    - d. Operating System(s) Software, where software is provided or upgraded
    - e. Application Software, with Optional and Custom Software Modules supplied in this project
    - f. Integration Schemes: Proposed connectivity, software, development requirements, and SDK information, for inter-system communication.



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- g. Network bandwidth and reliability requirements
  - h. Number and location of LAN ports required i. Other specific network requirements, preferences, and constraints
  - i. Backup/archive system size and configuration
  - j. Start-up operations
  - k. System power requirements and Uninterruptible Power Supply (UPS) sizing
  - l. Device/component environmental requirements (cooling and or heating parameters)
2. Shop Drawings: Shop Drawings shall be numbered consecutively and shall accurately and distinctly present the following information:
- a. Title Sheet:
  - b. Floor Plans: Showing devices, pull boxes, cabinets, conduits, and conductors in their proposed locations with device numbering scheme.
  - c. Riser Diagram: Showing all conduit relationships between devices shown on the Floor Plans. Show all power sources.
  - d. Single-Line/Block Diagrams: Show signal relationships of controls and devices within the system.
  - e. Custom Assembly Diagrams: For each custom assembly, such as Security Terminal Cabinets, receptacle assemblies, or door control panels, provide an assembly drawing illustrating the appearance of the assembled device. Include dimensions, assembly components, and functional attributes (momentary or alternate action switch, lens color, panel finish)
  - f. Component Connection Diagrams:
    - 1) For each equipment component, such as a computer, video switcher, camera or video recorder, show the rear elevation of the device and all connectors/terminations as a pictorial.
    - 2) Show the wire designations on connectors. Typical wiring detail where multiple of same device is provided.
    - 3) Show a schedule of the wire colors connected to the pins on each device connector
  - g. Equipment Wiring Diagrams:
    - 1) Show a pictorial illustration of each equipment enclosure and/or terminal cabinet, including terminals, components, and wiring devices.
    - 2) Show the device nomenclature exactly as shown on the single line diagrams.
3. Terminations: Show every termination and terminating cable, with applicable cable and wire numbers matching the single line diagrams.
- a. Every termination in the system must be documented.
  - b. Termination information may be rendered as a wiring list(s), if properly coordinated with, and referenced to, typical component and single-line diagrams. Otherwise, the Shop Drawings shall show a pictorial of every component in the system, with its terminations.
4. Show wire colors for each terminal.
5. For each wire exiting the enclosure, show the destination of the wire by floor, room number and the drawing number of the panel where the wire terminates.



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- F. Provide working dimensions and erection dimensions.
- G. Arrangements and sectional views
- H. Necessary details, including complete information for making connections between work under this Contract, existing work, and work under other Contracts.
- I. Stock or standard drawings will not be accepted for review unless full identification and supplementary information is shown thereon in ink or typewritten form.
- J. Duplicate of design drawings may be used where each sheet is modified to reflect contractor coordination, specific requirements of the project and multidiscipline conditions.
- K. Each Drawing or page shall include:
  - 1. Project name, Project Number, and descriptions.
  - 2. Submittal date and space for revision dates.
  - 3. Identification of equipment, product, or material.
  - 4. Name of Contractor and Subcontractor.
  - 5. Name of Supplier and Manufacturer.
  - 6. Relation to adjacent structure of material.
  - 7. Physical dimensions, clearly identified.
  - 8. ASTM and Specifications references.
  - 9. Identification of deviations from the Contract Documents.
  - 10. Contractor's stamp, initialed or signed, dated and certifying to review of submittal, certification of field measurements and compliance with Contract.
  - 11. Location at which the equipment or materials are to be installed. Location shall mean both physical location and location relative to other connected or attached material.
- L. Equipment Submittals
  - 1. Provide a Title Page, with project name, Contractors name and address, contact information, date of submission, and submission revision number.
  - 2. Provide a Parts List, for proposed equipment, materials, components and devices, listing the following information for each line item:
    - a. The system type
    - b. Model number
    - c. Specification sheet page reference
  - 3. Provide Manufacturers Specification Sheet with descriptive information for equipment, materials, components, and devices. Number each page, to correspond with the Parts List.
  - 4. Clearly delineate (with highlighter, arrow, or underline) on each specification sheet, specific model numbers, options and configurations being proposed for this project.
  - 5. Indicate kinds of materials and finishes for equipment where more than one option is presented.



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M. Acceptance Testing Plan

1. Submit a written document detailing the test procedures to be followed in evaluating and proving the installed system(s).
2. Provide a sample of the test forms to be used for each system and for each component of each system.
3. Include all tests required by the equipment manufacturer and by this Specification.

N. Spare Parts List: Submit a list of recommended spare parts. Spare parts shall comprise a minimum of 5% or minimum of 2 each of field devices, device termination boards and a minimum of 1 system controller boards.

O. Training Program

1. Submit a training program 10 working days prior to scheduled training to be followed in training key employees in the operation and maintenance of the installed system at the project site. The proposed training program shall be designed to provide a level of basic competence with the system for selected personnel. These selected personnel shall then be expected to train other personnel as required, utilizing the training that they have been given and the body of training documentation provided by Contractor. This plan shall comply with the requirements stated in the "Training" section, of these Specifications, all stated hours of which shall be considered to be classroom hours.
2. Submit a curriculum to account for, and relate, each subject to actual training time. All required hours shall be accounted for in this curriculum.
3. The training plan shall cover the overall system, each individual system, each subsystem, and each component. The plan shall also cover procedures for database management, normal operations, and failure modes with response procedures for each failure. Each procedural item must be applied to each equipment level.

P. The Owner will return unchecked any submittal which does not contain complete data on the work and full information on related matters.

Q. Verification: The contractor shall check and acknowledge all shop drawings, and shall place his signature on all shop drawings submitted to the Owner. Contractor's signature shall constitute a representation that all quantities, dimensions, field construction criteria, materials, catalog numbers, performance criteria and similar data have been verified and that, in his opinion, the submittal fully meets the requirements of the Contract Documents.

R. Timeliness: The Contractor shall schedule, prepare, and submit a complete shop drawing assembly in accordance with a time-table that will allow his suppliers and manufacturers sufficient time to fabricate, manufacture, inspect test and deliver their respective products to the project site in a timely manner so as to not delay the complete performance of the work.



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- S. Departure from Contract Requirements: If shop drawings show departures from the Contract requirements, the Contractor shall make specific mention thereof in his letter of transmittal, otherwise review of such submittals shall not constitute review of the departure. Review of the drawings shall constitute review of the specific subject matter for which the drawings were submitted and not of any other structure, materials, equipment, or apparatus shown on the drawings.
- T. Contractor Responsibility: The review of shop drawings will be general and shall not relieve the Contractor of responsibility for the accuracy of such drawings, nor for the proper fitting and construction of the work, nor for the furnishing of materials or work required by the Contract. No construction called for by shop drawings shall be initiated until such drawings have been reviewed and approved.
- U. Shop Drawing Submittal Review: The procedure in seeking review of the shop drawings shall be as follows:
1. The Contractor shall submit four (4) complete sets of shop drawings with equipment submittals and other descriptive data with one copy of a letter of transmittal to the Owner for review thirty (30) working days after award of the contract. The letter of transmittal shall contain the project name, the Owner's Project Number, the name of the Contractor, the list of drawings submitted including numbers and titles, requests for any review of departures from the contract requirements and any other pertinent information. Drawings submitted for review shall be full-sized drawings, rolled and included with the equipment submittals.
  2. Drawings or descriptive data will be stamped "Reviewed", "Furnish as Corrected", "Revise and Resubmit", "Rejected" or 'Submit Specific Item' and one copy with a Letter of Transmittal will be transmitted to the Contractor with the return of submitted documents.
  3. If a shop drawing or data is stamped "Reviewed" or "Furnish as Corrected", no additional submittal is required for that shop drawing.
  4. If a shop drawing or data is stamped "Revise and Resubmit" or "Rejected", the Contractor shall make the necessary corrections and resubmit the documents as required above. The letter transmitting corrected documents shall indicate that the documents are re- submittals.
  5. If any corrections, other than those noted by the Owner, are made on a shop drawing prior to resubmittal, such changes should be pointed out by the Contractor upon resubmittal.
  6. The Contractor shall revise and resubmit the shop drawing as required, until they are stamped either "Reviewed" or "Furnish as Corrected."
  7. After the Contractor's submittal or resubmittal of shop drawings, the Owner shall be provided with fifteen (15) working days for review. Should the Owner require additional review time above and beyond the stated fifteen (15) working days, the Contractor may ask for a time extension and/or monetary compensation, if they can present valid, factual evidence that actual damages were incurred by the Contractor. The Owner shall determine the amount of the time extension and/or the monetary compensation to be awarded the Contractor.



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8. The Owner will not issue a "Notice to Proceed" until shop drawings are reviewed, unless otherwise approved by the Owner.

V. The Contractor shall be responsible for extra costs incurred by the Owner caused by the Contractor's failure to comply with the procedure outline above.

1.11 OPERATING AND MAINTENANCE MANUALS: RECORD DOCUMENTS

A. Phase One:

1. Notwithstanding requirements specified elsewhere, submit the following labeled as the "Operating and Maintenance Manual" within thirty (30) days after Final Acceptance of the Installation:
  - a. Record Drawings: Submit two (2) copies of revised versions of drawings as submitted in the "Shop and Field" and "Equipment Wiring Diagrams" Submittals showing actual device locations, conduit routing, wiring and relationships as they were constructed. Include nomenclature showing as-built wire designations and colors. Drawings shall include room numbers coinciding with Owner space planning numbering. Drawings shall be submitted in electronic editable AutoCAD files, in ".dwg" format, on USB drive.
  - b. Manuals: Submit two (2) copies of each of the following materials in bound manuals, or electronic PDF copies on USB drive, with labeled dividers:
    - 1) A final Bill of Material for each system.
    - 2) Equipment Instruction Manuals: Complete, project specific comprehensive instructions for the operation of devices and equipment provided as part of this work.
    - 3) Manufacturers Instruction Manuals: Specification sheets, brochures, Operation Manuals, and service sheets published by the manufacturers of the components, devices and equipment provided.
    - 4) Include information for testing, repair, troubleshooting, assembly, disassembly, and recommended maintenance intervals.
    - 5) Provide a replacement parts list with current prices. Include list of recommended spare parts, tools, and instruments for testing and maintenance purpose.
    - 6) Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified herein.
    - 7) Warranties: Provide an executed copy of the Warranty Agreement and copies of all manufacturers' Warranty Registration papers as described herein.
2. Phase Two:
  - a. Within fourteen (14) days of receipt of engineer reviewed Operating and Maintenance Manual (Phase One), submit three (3) electronic copies in an editable AutoCAD .dwg format of the reviewed Record Drawings and three (3) copies of the reviewed Operating and Maintenance Manuals to the Owner, on USB drive.



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- 1) The contractor shall provide to the Owner one (1) copy of new executive and user software, including required graphical maps, on USB drive.
- 2) Sufficient information, (detailed schematics of subsystems, assemblies, and subassemblies to component level) clearly presented, shall be included to determine compliance with drawings and specifications.

1.12 CHANGES

- A. Before proceeding with changes or claims for extras, Contractor shall provide written notice, secure prior written approval from the Owner, and substantiate actual cost of each change or claim.

1.13 NOTIFICATION

- A. Contractor shall not shut off any existing systems. Contractor shall give the Owner at least 14 calendar day notice of any requirement to shut off or interfere with existing alarm, access control, regulating, computer or other service systems. The Owner will arrange and execute any shutdown. Work such as splicing, where approved, and connections necessary to establish or re-establish any system shall be completed by Contractor in close coordination with the Owner.

1.14 INTERFERENCE WITH THE FACILITY

- A. Transportation and storage of materials at the facility, work involving the facility, and other matters affecting the habitual use by the Owner of its buildings, shall be conducted so as to cause the least possible interference's, and at times and in a manner acceptable to the Owner. Contractor shall make every effort to deliver equipment per the schedule required by the project.

1.15 WARRANTY

- A. Furnish and guarantee maintenance, repair and inspection service for the system using factory trained authorized representatives of the manufacturer of the equipment for a period of one year after final acceptance of the installation.
- B. Third Party Device warranties are transferred from the manufacturer to the contractor, which may then transfer third party warranties to the Owner. Specific third-party warranty details, terms and conditions, remedies, and procedures, are either expressly stated on, or packaged with, or accompany such products. The warranty period may vary from product to product. These products include but are not limited to devices that are directly interconnected to the field hardware or computers and are purchased directly from the manufacturer. Examples may include but not be limited to; servers, cameras, video recorders, card readers, and computers.



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C. Purpose

1. The Contractor shall repair any system malfunction or installation deficiency discovered by the Owner during the burn in and warranty period.
2. The Contractor shall correct any installation deficiencies found against the contract drawings and specifications discovered by the Owner during the warranty period.

D. The service contract shall cover equipment and software related to this contract, and shall provide for the following parts and services, without additional cost to the Owner:

1. Quarterly Inspection, Preventative Maintenance and Testing of equipment and components
2. Regular Service, Emergency Service, and Call-Back Service
3. Labor and Repairs
4. Equipment and Materials

E. Response Time: Response time for service calls.

1. Emergency service calls where system is not responding to staff directed commands through the computer systems shall be within 2 hours to the project site.
2. Emergency service calls where controllers are not reporting shall be within 2 hours to the project site.
3. Normal service calls for device malfunctions shall be within 24 hours during normal working hours to the site.

F. Repair Time: Contractor shall stock parts in sufficient quantities such that repair or replacement shall be guaranteed within 12-hours. Temporary replacements within this time period shall be acceptable, provided temporary replacements do not compromise system functionality, and provided permanent replacement is achieved within 72 hours. Contractor may contact owner for use of owner supplied spare parts where delay of system repair will have negative impact on system performance.

G. Commencement: The warranty begins at the time of issuance of the statement of "Final Acceptance of the Installation" by the Owner.

H. Transferability: The warranty shall be transferable to any person or persons at the discretion of the Owner.

I. Transmittal: A copy of this Warranty shall be delivered to and signed for by the Owner. A copy of the signed Warranty document shall be delivered for review as part of the Final Submittals.

J. Registration: Register Warranty papers for all equipment and software in the name of the Owner. Furnish reproductions of all equipment Warranty papers to the Owner with the Final Submittals.



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- K. Sub-Contracting: Warranty service work may not be sub-contracted except with specific permission and approval by the Owner.
- L. Resolution of Conflicts
  - 1. The Owner retains the right to resolve unsatisfactory warranty service performance at any time by declaring the work unsatisfactory, stating specific areas of dissatisfaction in writing.
  - 2. If the Contractor or his approved subcontractor does not resolve such stated areas of dissatisfaction within thirty (30) days, the Owner may appoint any alternative service agency or person to fulfill the terms of the Warranty; the cost of which shall be borne by the contractor. This action may be taken repeatedly until the Owner is satisfied that Warranty service performance is satisfactory. Satisfactory resolution of a malfunction shall be considered adequate when the device, equipment, system, or component which is chronically malfunctioning is brought into compliance with the standards of performance as contained herein and published by the manufacturers of the equipment installed.

1.16 PERMITS AND INSPECTIONS

- A. Responsibility: Obtain permits and inspections required for the work. Permit and inspection costs will be borne by the Contractor.
- B. Performance: Perform tests required herein, or as may be reasonably required to demonstrate conformance with the Specifications or with the requirements of any legal authority having jurisdiction.
- C. Review: Obtain approvals from authorities responsible for enforcement of applicable codes and regulations to establish that the work is in compliance with all requirements of reference codes indicated herein and required by the appropriate jurisdiction. Make corrections, changes, or additions as required and deliver certificates of acceptance, operation, and/or compliance with the "Operating and Maintenance Manuals" as described herein.

1.17 TRAINING

- A. On-Site Training
  - 1. General: Present, review and describe equipment and materials to the Owner and Owner's operating personnel and fully demonstrate the operation and maintenance of the systems, equipment and devices specified herein.
  - 2. Training shall comprise two separate levels of training;
    - a. User Group upon substantial completion of the project
      - 1) User group training shall include a site/building walk through indicating locations of equipment and their usage
      - 2) User group training shall include the operation of workstation capability of system monitoring, command override and report generation.



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- b. Maintenance Group upon completion of the project prior to close out
  - 1) Maintenance group training shall include a site/building walk through indicating locations of equipment and their usage
  - 2) Review of as-build documentation at each controller location
  - 3) Trouble shooting techniques in hardware and software
- 3. The training shall also cover procedures for database management, normal operations, and failure modes with response procedures for each failure. Each procedural item must be applied to each equipment level.
- 4. Duration: Provide at least 2 hours of on-site training on each system for each group of designated representatives of the Owner at a location convenient to the Owner.
- 5. On-site training shall commence as follows:
  - a. EACS: Just prior to completion of the first phase of work which establishes the new EACS control over entry and exit portals.
  - b. VSS: Just prior to completion of the first phase of work which establishes the new VSS control over video cameras.
  - c. IDS: Just prior to completion of the first phase of work which establishes the new IDS control over intrusion devices.

1.18 SAFEGUARDS AND PROTECTION

- A. Barriers: Provide and maintain suitable barriers, guards, fences and signs where necessary to accommodate the safety of others relative to and/or for the protection of this work.
- B. Regulations: Comply with OSHA, Federal, State, and local regulations and standards pursuant to this work.
- C. Protection: Protect all materials and equipment to prevent the entry or adhesion of any and all foreign material. If necessary, cover equipment with temporary protective material suitable for this purpose.
- D. Finishing: Check, clean and remove defects, scratches, fingerprints, and smudges if necessary from all equipment and devices immediately prior to Acceptance of the Installation.
- E. Damage: Replace all damaged or defective material or work at no additional cost prior to Final Acceptance.
- F. Documentation: Provide written description of accidents by workers, and staff of any incident occurring on the project. Report incident in writing to Owner immediately and to the Project Manager for follow up.



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1.19 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Unless otherwise noted, pre-testing or configuration is required by the contractor, deliver materials to the job site in manufacturer's original unopened containers, clearly labeled with the manufacturer's name and equipment model identification number.
- B. Storage and Handling: Store and protect equipment in a manner which will preclude damage.

1.20 EQUIPMENT COMPATIBILITY REQUIREMENTS

- A. While individual items of equipment may meet the equipment specifications and in fact meet the system specifications, the total system shall be designed so that the combination of equipment actually employed does not produce any undesirable effects such as signal distortion, noise, transients, or crosstalk interference's when electrically associated with itself or other equipment.

1.21 OWNER'S RIGHT TO USE EQUIPMENT

- A. The Owner reserves the right to use equipment, material and services provided as part of this work prior to Acceptance of the Work, without incurring additional charges and without commencement of the Warranty period.

1.22 WORK INCLUDED

- A. The Electronic Security Infrastructure installed and work performed under this division of the Specifications shall include but not necessarily be limited to the following:
- B. Electronic Access Control
- C. Intrusion Detection
- D. Video Surveillance
- E. Conduits, raceways, racks, cabinets and equipment mounting boards as indicated on the Drawings
- F. Grounding and Bonding

1.23 DEFINITIONS

- A. Terms: The following definitions of terms supplement those of the General Requirements and are applicable to Division 28 - Electronic Security.



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- B. Provide: As used herein shall mean “furnish, install and test (if applicable) complete.”
- C. Infrastructure: As used herein shall mean cable, conduit, raceway with all required boxes, fittings, connectors, and accessories; completely installed.”
- D. Work: As used herein shall be understood to mean the materials completely installed, including the labor involved.

1.24 DRAWINGS

- A. Drawings are generally diagrammatic and show the arrangement and location of pathways, outlets, support structures and equipment. The Contractor shall carefully investigate the structural and finish conditions affecting his work and arrange his work accordingly. Should conditions on the job make it necessary to make adjustments to pathways or materials, the Contractor shall so advise the Engineer and secure approval before proceeding with such work.
- B. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, the Contractor shall request drawings, equipment location drawings, foundation drawings, and any other data required by him to locate the concealed conduit before the floor slab is poured.
- C. Materials, equipment or labor not indicated but which can be reasonably inferred to be necessary for a complete installation shall be provided. Drawings and Specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.
- D. The right is reserved to make reasonable changes in locations of equipment indicated on Drawings prior to rough-in without increase in contract cost.
- E. The Contractor shall not reduce the size or number of conduit runs indicated on the Drawings without the written approval of the Engineer.
- F. Any work installed contrary to Contract Drawings shall be subject to change as directed by the Engineer, and no extra compensation will be allowed for making these changes.
- G. The location of equipment, support structures, outlets, and similar devices shown on the Drawings are approximate only. Do not scale Drawings. Obtain layout dimensions for equipment from Architectural plans unless indicated on Electronic Security plans.
- H. Schematic diagrams shown on the Drawings indicate the required functions only. The technology of a particular manufacturer may be used to accomplish the functions indicated without exact adherence to the schematic Drawings shown. Additional labor and materials required for such deviations shall be furnished at the Contractor's expense.



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- I. Verify the ceiling type, ceiling suspension systems, and clearance above hung ceilings prior to ordering cabling and associated hardware. Notify the Engineer of any discrepancies.
- J. Review all architectural drawings for modular furniture.
- K. Portions of these Drawings and Specifications are abbreviated and may include incomplete sentences. Omissions of words or phrases such as "the Contractor shall," "shall be," "as indicated on the Drawings," "In accordance with," "a," "the" and "all are intended" shall be supplied by inference.

1.25 SUBMITTALS

- A. Submit for approval, details of all materials, equipment and systems to be furnished. Work shall not proceed without the Owner and/or the Project Manager's approval of the submitted items. Three (3) copies of the following shall be submitted:
  - 1. Submittals for individual systems and equipment assemblies that consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered, reviewed or stored, and such submittals will not be returned except at the request and expense of the Contractor.
  - 2. Contractor shall generate shop drawings. Modify reviewed and accepted shop drawings to include revisions based upon completion of work. Submit shop drawings with record drawings on hard copy.
  - 3. Shop drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details and any other details not included in the construction drawings.
- B. Any materials and equipment listed that are not in accordance with Specification requirements may be rejected.
- C. The approval of material, equipment, systems and shop drawings is a general approval subject to the Drawings, Specifications and verification of all measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. The Contractor shall carefully check and correct all shop drawings prior to submission for approval.

1.26 QUALITY ASSURANCE

- A. Equipment and materials required for installation under these Specifications shall be the current model and new (less than one [1] year from the date of manufacture), unused and without blemish or defect.
- B. Equipment shall bear labels attesting to Underwriters Laboratories or certification by other recognized laboratory, where subject to label service. Manufacturers of equipment and materials pertinent to these items shall have been engaged in the



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manufacture of said equipment a minimum of three (3) years and, if so directed by the Owner, be able to furnish proof of their ability by submitting affidavits and descriptive data about their product including size and magnitude comparable to requirements specified herein.

1.27 CONTRACTOR QUALIFICATIONS

- A. The Contractor shall have total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications. The Contractor shall be a company specializing in the design, fabrication and installation of integrated electronic security systems.
- B. Electronic Security Systems specified shall be installed under the direction of a qualified contractor. Qualification requirements shall include submittal by the Contractor to the Architect of the following:
- C. List of previous projects of this scope, size and nature; including names and sizes of projects, description of work, time of completion and names of contact persons for reference.
- D. Contractor shall certify that they are manufacturer-authorized for work to be performed.
- E. Contractor must employ at least one (1) full-time Registered Communications Distribution Designer (RCDD). The RCDD shall be a W2 employee and not a subcontractor.

1.28 COORDINATION WITH OTHER TRADES

- A. The Contractor shall coordinate electronic security work with that of other sections as required ensuring that the entire electronic security work will be carried out in an orderly, complete and coordinated fashion.

1.29 SITE INVESTIGATION

- A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems, shall be restored to their original condition before the completion of this project.

1.30 RENOVATIONS AND ADDITIONS

- A. All work that would adversely affect the normal operation of the other portions of the Owner's property shall be done at a time other than normal working hours. Normal working hours shall be considered 8 a.m. to 5 p.m. Monday through Friday.



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- B. Prior to submitting bids on the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project.
- C. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original and operating condition. Remove all equipment indicated to be demolished, including outlets, devices, raceways and support structures.
- D. Care shall be exercised in the removal and storage of equipment indicated to be relocated or removed and reused. Prior to placing back into service, equipment shall be cleaned, and marred or chipped paint surfaces touched-up.
- E. Provide all coring, cutting and patching to existing walls, floors, etc., required for the removal of existing work or the installation of new work.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. These general criteria shall apply to "Part 2-Products" of all Access Control specifications that are a part of this work.
- B. Product Acceptability: Products sections contain lists of Owner acceptable products. If product substitutions are proposed, they must be made based upon a comparison of equivalence to the product specified. Considerations may include but shall not be limited to functional, physical, aesthetic and/or interface aspects. The Owner shall be the sole judge of whether or not a submitted substitution is deemed to be "equivalent" to that specified.
- C. Manufacturers Specification Reference: Where a specific material, devices equipment or systems are specified directly, the current manufacturers' specification for the same becomes a part of these specifications, as if completely elaborated herein.
- D. Equipment shall be new and the current model of a standard product of a manufacturer of record. A manufacturer of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied.
- E. For each item of equipment offered, manufacturer shall maintain:
  - 1. A factory production line.
  - 2. A stock of replacement parts.
  - 3. Engineering drawings, specifications, operating manuals and maintenance manuals.
  - 4. Manufacturer shall have published and distributed descriptive literature and equipment specifications on each item of equipment offered.



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- F. Complete System: Auxiliary and incidental equipment necessary for the complete operation and protection of the systems specified herein shall be furnished and installed as if specified in full.
- G. Similar Devices: Similar devices within a system shall be identical unless specific color variances are required by the Owner or Architect.
- H. Safety: Unless otherwise specified, equipment shall be UL rated individually and listed as an assembly. Electronic equipment shall be of the dead front type, having no exposed live electrical connections, terminals or exposures to hands-on operating surfaces or other exposed surfaces during any power-on condition. Every live electrical connection, terminal or exposure shall be covered with durable, removable insulating material.
- I. Rack Mounting: Rack-mounted electronic equipment shall be specifically designed or modified for standard 19-inch rack mounting unless otherwise noted.
- J. Keying: Key panels identically where provided for similar usage within a system. Coordinate lock types with Owner.
- K. Framing: Floor supported units shall be substantially framed and supported. All bolted connections shall be made with self-locking devices.
- L. Aesthetics: Coordinate console or control panels so that their general appearance is similar. Provide locking panel covers on recessed, semi-recessed and surface mounted control panels not located in equipment rooms. Control panels shall be contained within or mounted to formed and welded aluminum or steel back-boxes. Operating panels shall be recessed within the back-box to a depth sufficient to permit a locking hinge panel cover to close completely without affecting any device within the enclosure.
- M. No contractor proprietary equipment will be permitted without prior approval from the Owner.
- N. Operational Voltage: Devices connected to the fuse or breaker protected electrical system and all auxiliary equipment necessary for the operation of the equipment associated with systems specified herein shall be designed to operate from 105 to 130 volt, 60 Hertz, alternating current service, with stable performance, fully in accordance with these specifications, and shall have integral fuse or circuit breaker protection.
- O. Contractor-fabricated items shall be provided with fuses that indicate when they are blown or defective.
- P. Protection devices shall be located to facilitate replacement, resetting or observation of status without demounting the associated unit and/or de-energizing adjacent equipment.



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- Q. Manufacturer's Recommendations: Components and devices shall be operated in accordance with recommendations of the manufacturer and shall contain sufficient permanent identification to facilitate replacement.
- R. Testing Requirements:
1. Equipment, devices, and assemblies shall meet the local city requirements for listing and labeling, which includes UL listing and labeling for manufactured equipment.
  2. UL Listing: For devices and assemblies with proper UL listing and labeling, stickers shall be accessible and visible to the Inspectors. Paperwork shall also be available during inspections and shall be provided to the Owner as part of the close out documentation
  3. Unlisted Devices and Assemblies: Devices and assemblies without prior listing from testing authorities accepted by the local city, shall be tested by an agency acceptable to the local city prior to inspection, to obtain a listing and label. Documentation on the testing and approval shall be provided to the Owner as part of the close out documentation.

## 2.2 MISCELLANEOUS PRODUCTS

- A. Cabinets: Hoffman, Rittal or equal, assembled and wired with all components and as indicated on the drawings. Coordinate color, location, and trim with the Owner.
- B. Cable Termination Devices: Screw-Type Barrier Blocks: Marathon/Kulka 601 or Kulka 601-3700 Series, TRW-Cinch, 140, 141 and 142 Series, Phoenix or Buchanan.
- C. Relays: Control relays to be provided by the Contractor shall meet or exceed the following:
1. Provide U.L. listed single pole, double throw (SPDT) type, unless otherwise noted on the drawings, with silver tin oxide contacts.
  2. They shall have a contact rating of 250 V AC/DC at 6A on normally open contacts and 2A on normally closed contacts.
  3. Control relay bases shall be UL listed, DIN rail mounted style, and shall be compatible with the proposed control relay. They shall have screw terminals for all wiring leads accepting conductors up to size 14 AWG. Relay bases shall have provisions for accepting machine printed labels.
  4. Control Relays: Provide relays and bases by Potter & Brumfield, Square D, or equal.
  5. Power Relays: Provide American Electronic Components relays or equal by Potter & Brumfield.
- D. Wire and Cable Management: Provide Thomas and Betts Ty-Duct Series of Slotted Wiring Ducts, or equal by Marathon, or Eaton. Wiring duct shall be used within cabinets, enclosures, and terminal boxes for the distribution and management of cables within the enclosures. Provide compatible mounting hardware, end caps,



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labeling and appurtenances to form a complete wire management system. Comply with manufacturers recommended maximum fill schedules.

E. Theft Proof Screws

1. Provide Tamperproof security fasteners for the installation of security equipment, cabinets, enclosures and pull boxes in accessible locations. Provide Bryce Fastener PentaPlus series, TP3 style by Tamperproof Screw Company, or equal by Hudson Fastener.
2. Provide six (6) compatible screw drivers and transfer to the Owner prior to final acceptance testing.

F. Equipment Enclosure

1. Indoor Wall Mount Rack Enclosures
  - a. Provide Atlas WMA Series, or Bud Cabinets Emperor Series, or equal, sectional wall cabinets, with door and mounting rails for standard 19" rack mount equipment.
  - b. Cabinet shall be in three sections: solid door, center section, and rear section. Door and center section shall swing out, permitting service from the rear without disassembling equipment. Center section depth shall be 15", minimum.
  - c. Contractor shall size the height of the cabinet to house applicable equipment, terminals, wire and devices in a neat and workmanlike manner.
2. Outdoor Enclosures: Provide Hoffman DesignLine Type 3R or Type 4 Enclosure, or equivalent, with 10 Gage steel body and door, swing-out rack mount, and extension ring kits as required to house specified equipment. Provide tamper resistant key lock. Contractor shall size the cabinet to house applicable equipment, terminals, wire and devices in a neat and workmanlike manner.

2.3 TEST EQUIPMENT

- A. The Contractor is responsible for providing test equipment required to test the system in accordance with the parameters specified. Unless otherwise stated, the test equipment shall not be considered part of the system and retain ownership of the equipment. The Contractor shall furnish test equipment of an accuracy better than the parameters to be tested.
- B. The test equipment list shall be furnished as a part of the submittal. C. Readiness: Keep test equipment at hand and maintain in calibrated condition at the jobsite as required for routine and performance testing of this work.

2.4 VIDEO SURVEILLANCE SYSTEM (VSS)

- A. Genetec or Avigilon



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1. The system provides visual monitoring of strategic areas of the building perimeter and entrances, and is entirely LAN network-based, using TCP/IP encoders, digital video recorders, digital recording media, network video recorders and “virtual” switching / viewing software.
2. Command and Control: The system is monitored and managed from the Security Operations Center, via VSS workstations and the appropriate viewing software. Connectivity is made via the campus Local Area Network (LAN).

B. Modifications to the Existing System

1. The Contractor shall use and expand, as necessary, the existing system as part of this work, including but not limited to servers, encoders, recorders, input/output modules, control keyboards, workstations, software, software licensing, wiring, cameras, and appurtenances.
2. Contractor shall subcontract with the Owner’s service and maintenance providers to ensure new additions and modified systems are fully and seamlessly integrated into the existing system.

C. Contractor and Manufacturer shall guarantee in writing equipment and software which is added as part of this work is fully compatible with the existing system, is fully supported by the existing system manufacturer(s), and is configured as described in the specifications. New equipment shall be fully warranted by the Contractor as specified herein.

D. Contractor shall ensure hardware and software is fully integrated into the existing system to present a single, seamless operating system. Contractor shall fully develop and support all hardware and software integration schemes.

E. Control components which require unique, or proprietary, hardware or software interfaces to achieve parity with the existing system architecture are not acceptable.

F. If records exist, drawings and diagrams of the existing systems will be made available, through the Owner, to the Contractor. The Contractor shall survey, research and confirm the existing equipment and configuration in-place, and coordinate expansion of the systems with the Owner to avoid any interruption in services.

G. Contractor shall guarantee the existing equipment and software shall be protected from corruption or damage during the installation, programming and commissioning process.

2.5 SUBSTITUTIONS

A. Where equipment is identified by manufacturer and catalog number, it shall be as the base of requirements for quality and performance. Where manufacturers for equipment are identified by name, the Contractor may submit for approval, similar equipment of other manufacturers as substitution. The Engineer's decision as to whether the submitted equipment is acceptable shall be final and binding.



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- B. All changes necessary to accommodate the substituted equipment shall be made at the Contractor's expense, and shall be as approved by the Engineer. Detailed drawings indicating the required changes shall be submitted for approval at the time the substitution is requested.
- C. If substitutions are made in lieu of device specified; form, dimension, design and profile shall be submitted to the Engineer for approval.
- D. Submit request for approval of substitute materials in writing to the Architect at least ten days prior to bid opening.

## 2.6 MATERIALS

- A. All materials used in this work shall be new and shall bear the inspection label of Underwriters Laboratories Inc. or certification by other recognized laboratory.
- B. The published standards and requirements of the Telecommunications Industries Association (TIA), National Electrical Manufacturers Association (NEMA), the American National Standard Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), and the American Society of Testing Materials (ASTM), are made a part of these Specifications and shall apply wherever applicable.
- C. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.
- D. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer or partner manufacturers that offer a certified solution.
- E. Components of an assembled unit need not be products of the same manufacturer, but must offer a certified end-to-end solution.
- F. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
- G. Components shall be compatible with each other and with the total assembly for the intended service.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Perform this work in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.



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- B. Aesthetics are an important consideration in this installation. Components shall be installed so as to have aesthetically pleasing results per Owner and Architect requirements. Actual locations of visible components shall be coordinated in advance with Owner and Architect.
- C. The Contractor shall insure that installation personnel understand the requirements of this Specification.

### 3.2 EXAMINATION OF CONDITIONS

- A. Prior to the start of work, the Contractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.
- B. Install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.
- C. In the event of a discrepancy, immediately notify the Project Manager.
- D. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

### 3.3 COORDINATION

- A. General
  - 1. This Contract involves functioning systems. Coordination with the Owner is critical. Do not interrupt any functioning system without complying with the requirements of "Notification" section of this specification.
  - 2. Coordinate the work with the Owner and all trades to assure that where this work interfaces to other trades, those interfaces are provided, complete and functional.
  - 3. Meet with the Owner and each trade. Identify devices needed to complete functional operation of this work which are being provided by Owner, General Contractor or another trade, and assure that the work being provided by others will be acceptable.
  - 4. Make sure work by others is scheduled in order that this work can be installed in a timely fashion.
  - 5. Verify dimensions, and work by others which may be necessary to facilitate the work and coordinate with other trades. Assure that related work by others is coordinated with this work.
  - 6. Verify field conditions. Regularly examine construction and the work of others which may affect the work to ensure proper conditions are provided for the equipment and devices before their manufacture, fabrication or installation. Be responsible for the proper fitting of the systems, equipment, materials, and devices provided as part of this work.



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- B. Required Resources: Become familiar with the available access and space for equipment and any potential interference requiring coordination. Coordinate with the Owner to assure that adequate electrical and HVAC, services are available. Provide the physical space for equipment, and ample access room for installation and maintenance of equipment.
- C. Positioning Members: Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Owner without additional expense.
- D. Interface Devices: Provide items necessary to complete this work in conformance with the Contract Documents or the satisfaction of the Owner without any additional expense.
- E. Equipment shall be mounted with sufficient clearance to meet applicable codes and facilitate observation and testing. Securely hang and/or fasten with appropriate fittings to ensure positive grounding, free of ground loops, throughout the entire system. Units shall be installed parallel and square to building lines.
- F. Installation shall comply with "Codes and Standards" section of this specification. Where more than one code or regulation is applicable, the more stringent shall apply.
- G. Where new equipment is replacing old equipment, Contractor is responsible for removing the old equipment and doing repair work necessary to meet standards determined by Owner.
- H. Install fire stopping for penetrations in slabs and firewalls to meet code at the completion of work and prior to final testing demonstration to Owner.
- I. Project Documentation: Review project documentation. If the Contractor perceives conflict or ambiguity in the contract documents, he shall seek interpretation from the Owner. Failure to do so may result in remedial work.
- J. Project Schedule: Immediately obtain and follow the project schedule established by the Owner. Failure to maintain the schedule may result in a requirement by the Owner to expend extra effort until the project schedule has been achieved.
- K. Schedule Changes: Time is of the essence of this agreement. In the event that it becomes necessary for the Contractor to expend "extra effort" to complete the work according to schedule changes not covered above, the Contractor agrees to cooperate with the Owner in good faith to complete the work according to schedule requirements.
- L. Supervision: Maintain a competent supervisor and supporting technical personnel acceptable to the Owner during the entire installation. A change of supervisor during the project shall not be acceptable without prior written approval from the Owner.
- M. Work and Manpower Rules: Comply with applicable jobsite work and manpower regulations.



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- N. Found Conflicts: Continuously make known to the Owner, conflicts discovered which may affect the orderly completion or the specified performance of this work. Cooperate with the Owner and other trades to accommodate such changes as may be necessary to resolve found conflicts.
- O. Coordination Difficulties: Promptly notify the Owner in writing of any difficulties which may prevent proper coordination or timely completion of this work. Failure to do so shall constitute acceptance of construction as suitable, to receive this work, except for defects that may develop in the work of others after its execution.
- P. Environmental: Verify the intended location(s) for equipment is suitable for the equipment. If conditions such as temperature, humidity, dust level or the like require modification, make it known to the Owner immediately upon award of the contract. If equipment requires strict environmental conditions (dust limitations, etc.), notify the Owner immediately upon award of the Contract. Failure to notify the Owner of such conditions shall constitute acceptance of the conditions and any later required modifications to the equipment or the environment shall be at the sole cost of the Contractor.
- Q. Extra Effort: The Owner retains the right to require the Contractor to expend whatever extra effort as may be required, in event the Contractor fails to perform satisfactorily at any milestone date, unless such delay is approved in writing by the Owner, or it can be proved by the Contractor that such delay was caused by other contractors, or Owner's intransigence relating to Owner requested changes in the scope of work. Any costs pursuant to such extra effort will be borne solely by the Contractor. If Project Schedule delays are approved, provide the Owner with monthly revisions of the Project Schedule reflecting actual performance vs. the schedule.

### 3.4 PROTECTION OF SYSTEMS AND EQUIPMENT

- A. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.
- B. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering the sides with securely fastened protective rigid or flexible waterproof coverings.
- C. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.
- D. As determined by the Project Manager, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Project Manager shall be final.



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- E. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with the same quality of paint and workmanship as used by the manufacturer.

### 3.5 SEISMIC PROTECTION

#### A. MEP Component Anchorage

1. All mechanical components shall be anchored and installed per the details on the DSA approved construction documents. Where no detail is indicated, the following components shall be anchored or braced to meet the force and displacement requirements prescribed in the 2019 CBC sections 1617a.1.18 through 1617a.1.26 and ASCE 7-16 chapter 13, 26 and 30.
  - a. All permanent equipment and components.
  - b. Temporary or movable equipment that is permanently attached (e.g. hard wired) to the building utility services such as electricity, gas or water. "permanently attached" shall include all electrical connections except plugs for 110/220 volt receptacles having a flexible cable.
  - c. Temporary, movable or mobile equipment which is heavier than 400 pounds or has a center of mass located 4 feet or more above the adjacent floor or roof level that directly support the component is required to be restrained in a manner approved by DSA.
2. The following mechanical and electrical components shall be positively attached to the structure but need not demonstrate design compliance with the references noted above. These components shall have flexible connections provided between the component and associated ductwork, piping, and conduit. Flexible connections must allow movement in both transverse and longitudinal directions:
  - a. Components weighing less than 400 pounds and have a center of mass located 4 feet or less above the adjacent floor or roof level that directly support the component.
  - b. Components weighing less than 20 pounds, or in the case of distributed systems, less than 5 pounds per foot, which are suspended from a roof or floor or hung from a wall.
3. The anchorage of all mechanical, electrical and plumbing components shall be subject to the approval of the design professional in general responsible charge or structural engineer delegated responsibility and acceptance by DSA. The project inspector will verify that all components and equipment have been anchored in accordance with the above requirements.

#### B. Piping, Ductwork, and Electrical Distribution System Bracing Note

1. Piping, ductwork, and electrical distribution systems shall be braced to comply with the forces and displacements prescribed in ASCE 7-16 section 13.3 as defined in ASCE 7-16 sections 13.6.5, 13.6.6, 13.6.7, 13.6.8; and 2019 CBC, sections 1617a.1.24, 1617a.1.25 and 1617a.1.26.



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2. The method of showing bracing and attachments to the structure for the identified distribution system are as noted below. When bracing and attachments are based on a preapproved installation guide (e.g., OSHPD OPM for 2013 CBC or later), copies of the bracing system installation guide or manual shall be available on the jobsite prior to the start of and during the hanging and bracing of the distribution systems. The structural engineer of record shall verify the adequacy of the structure to support the hanger and brace loads.
3. Mechanical piping (MP), mechanical ducts (MD), plumbing piping (PP), electrical distribution systems (E):
  - a. Option 2: Shall Comply with the applicable OSHPD Pre-Approval OPM#.

C. General

1. Seismic protection criteria: Electrical and mechanical machinery installations in any Seismic Risk Zone of the Uniform Building Code Seismic Risk Map shall be protected from earthquakes per California Building Code 2019 Chapter 35 Referenced Standards.
  2. Protection criteria for these zones shall be a Horizontal Force Factor not less than required by code or agency, considered passing through the machinery center of gravity in any horizontal direction.
  3. Unless vibration isolation is required to protect machinery against unacceptable structure transmitted noise and/or vibration, machinery shall be protected from earthquakes by rigid structurally sound attachment to the load supporting structure. The number shall be determined by calculations performed by a registered California professional engineer, as verified by the seismic restraint vendor.
  4. Use protected spring isolators, or separate seismic restraints, to protect vibration isolation machinery.
  5. Seismic snubbers and protected spring isolators shall be seismic protection-rated along three principal axes, proven by independent laboratory testing or analysis, by an independent, licensed structural engineer.
- D. The Contractor shall be responsible for the design of his method for seismic restraint systems, and shall supply all seismic calculations and details to the Owner for review. The Contractor shall supply to the Owner details of the forces exerted by his restraints, anchorages, and other points of attachment.
- E. Electrical and mechanical equipment shall be installed in accordance with the following guidelines:
1. SMACNA Publication: Guidelines for Seismic Restraints of Mechanical Systems
  2. California Code of Regulations (CCR), Title 24, Division 22
  3. NUSIG – National Uniform Seismic Installation Guidelines
- F. Contractor shall submit shop drawings for the mounting of equipment, fixtures, cabinets, consoles, conduit, and cable support racks (where required). These drawings shall be prepared, stamped, and signed by a Registered California Structural Engineer.



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3.6 ACCESS TO EQUIPMENT

- A. Equipment shall be installed in location and manner that will allow convenient access for maintenance and inspection.
- B. Working spaces shall be not less than specified in the National Electrical Code (NEC) for voltages specified.
- C. Where the Project Manager determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the Project Manager, at no additional cost to the Owner. "Conveniently accessible" is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

3.7 CLEANING

- A. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by electronic security work.
- B. Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.

3.8 COMPLETION

- A. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.
- B. Results Expected: Systems shall be complete and operational and controls shall be set and calibrated. Testing, start-up and cleaning work shall be complete.
- C. Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.

3.9 WORKMANSHIP

- A. The installation shall be performed in a professional and workmanlike manner.
- B. On a daily basis, clean up and deposit in appropriate containers debris from work performed under the appropriate Specification sections. Stack and organize parts, tools and equipment when not being used.
- C. Preparation, handling, and installation shall be in accordance with the Manufacturer's written instructions and technical data appropriate to the product specified.



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- D. Work shall conform to the National Electrical Contractor's Association "Standard of Installation" for general installation practice.
- E. At the conclusion of the installation, work areas, including panel boxes, shall be vacuumed and cleaned to remove debris and grease.

3.10 TESTING AND VERIFICATION

- A. See specific Division 28 sections for testing parameters of sub-systems.
- B. The Contractor shall verify that requirements of this Specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.
- C. Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the Specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the Owner.
- D. The Contractor shall verify by formal demonstrations or tests that the requirements of this Specification have been met. The Contractor shall demonstrate that the electronic security systems, components and subsystems meet Specification requirements in the "as-installed" operating environment during the "System Operation Test." Even though no formal environmental testing is required, the Contractor shall measure and record temperature, humidity and other environmental parameters and the environmental conditions, which were encountered during the "System Operation Test."
- E. The Contractor shall carefully plan and coordinate the final acceptance tests so that tests can be satisfactorily completed. The Contractor shall provide necessary instruments, labor and materials required for tests, including the equipment manufacturer's technical representative and qualified technicians in sufficient numbers to perform the tests within a reasonable time period.
- F. The Contractor shall satisfy all items detailed in the final acceptance check-off list (punch list). The list shall be a complete representation of specified installation requirements. At the time of final acceptance punch list items shall be corrected until the system is found to be acceptable to the Owner and the Project Manager.
- G. After the Contractor systems have been installed and tested, the completed test plan shall be signed by the Electronic Security Contractor Project Manager and submitted for approval.

3.11 EQUIPMENT ENCLOSURES, RACK, AND CONSOLE INSTALLATION

- A. Construction: Coordinate access openings and wire paths through the cabinets for all desk mounted devices



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- B. Compliance: Comply with powering, conduit entry and grounding practices as described herein and as required by code.
- C. Coordination of Access: Coordinate the installation of access covers, hinged panels or pull-out drawers to ensure complete access to terminals and interior components. Access shall be designed such that demounting or de-energizing of equipment is not required to gain access to any equipment.
- D. Enclosures: Fasten removable covers containing any wired component with a continuous hinge along one side with associated wiring secured and dressed to provide an adequate service loop. Appropriate stop locks shall be provided to hold all hinged panels and drawers in a serviceable position.
- E. Service Loop: Provide a wiring service loop allowing relocation of termination to any point within the enclosure.

### 3.12 CUTTING, PAINTING AND PATCHING

- A. Structural members shall not be drilled, bored or notched in such a manner that shall impair their structural value. Cutting of holes in structural members, if required, shall be done with core drills and only with the specific approval of the Owner for each instance. Provide means to identify rebar in slabs prior to drilling.
- B. Walls and other architectural features that require cutting or repair during the installation process shall be returned to their original condition, including the matching of colors, and finishes to the satisfaction of Owner, and at no additional cost to Owner.

### 3.13 GROUNDING PROCEDURES

- A. Provide grounding of systems and equipment in accordance with manufacturer's recommendations, local electrical codes, and industry standards.
- B. Signal Ground: Signal ground shall be derived from the one main electrical panel which serves all equipment herein.
- C. Grounding procedures for wire, equipment and devices shall be in strict accordance with manufacturers' recommendations and standard installation practices.
- D. Equipment enclosures of an assembly shall be grounded to the single grounding terminal strip of each assembly.
- E. Multiple Powered System Isolation: Where powered devices of the same system exist in two or more locations and a different signal ground exists in each location, the system's communication signal shall be isolated from signal ground at both source and destination ends via modem, fiber optics or other equivalent method.



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- F. Contractor shall eliminate or correct potential ground-loop problems in a manner approved by the Engineer.
- G. Shielding: Shielded cables of this section shall be grounded exclusively to Signal Ground. No shields shall be permitted to carry live currents of any kind. Shields shall be tied to Signal Ground at the signal source end only, unless otherwise noted or required by the manufacturer.

3.14 CONDUIT AND WIRE INSTALLATION PRACTICES

A. Conduit

1. Conduit shall be 1-inch minimum unless noted otherwise on the drawings
2. Wires shall be installed in conduit or in another Owner approved raceway for power and exposed wiring, in areas where mechanical or environmental conditions may damage conductors, and where otherwise specified herein or required by code.
3. Conduit or raceway that is not hidden must have its location and appearance be specifically approved by Owner. If approved, exposed conduit or raceway shall be run in such a fashion as to make it as inconspicuous as possible. Runs should follow existing building lines and should be square wherever possible.
4. Verify conduit has been installed, de-burred and properly joined, routed, and terminated prior to pulling of cables.
5. Apply a chemically inert conduit lubricant to wire and cable prior to pulling. Do not subject wire and cable to tension greater than recommended by the manufacturer
6. Secure wire and cable runs vertically in conduit for continuous distances greater than thirty (30) feet at the vertical run terminations. Non-coaxial cables shall be secured by screw-flange nylon cable ties or similar devices. Symmetrical clamping devices with split, circular, or other wire conforming, nonmetallic bushings shall be provided for other cables.

B. Wiring Without Conduit

1. Wiring may be run in concealed spaces without conduit, in electrical trays, and where otherwise shown on drawings, provided conductors are reasonably protected from mechanical and environmental damage.
2. Any security wiring that is visually exposed must be installed in conduit
3. Conductors run without conduit shall be approved, UL Listed, rated and labeled for Plenum use.
4. Secure wire and cable with approved supports in accordance with the referenced standards and the Authority Having Jurisdiction.
5. Provide cable supports at a minimum of 4-foot intervals.
6. Equipment and devices shall be installed on approved electrical back-boxes. Do not install equipment and devices directly on walls, ceilings, or structural components without back-boxes.
7. Secure cables to cabinets, junction boxes, pull boxes and outlet boxes with approved cable clamps.



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8. Independently support cables. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts).
9. Support cable independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
10. Support cable using cable trays, D-brackets, support straps, support wires or other approved cable supports.
11. Fasten cable supports to building structure and surfaces.
12. In shared electrical trays, open ducts, and other cable runs without conduit, separate and strap Access Control cable so that it is clearly distinguishable from all other cables.
13. Clearly mark security system cables at minimum intervals of every 10-feet. Marking shall be with a permanent, printed label, color-coded tag, or other distinguishing marking. Felt tip pen marking on the cable is not acceptable.

C. New Wiring

1. After installation, and before termination, wiring shall be checked and tested to insure there are no grounds, opens, or shorts on any conductors or shields. In addition, wiring between buildings or underground and all coax cables shall have insulation tested with a megohmmeter and a reading of greater than 20 megaohms shall be required to successfully complete the test.
2. Run wires continuously from termination to termination without splices. Splices at junction box locations may be allowed at the discretion of the Owner. Recommendations for splices at these points shall be established with Owner. Contractor shall obtain approval from the Owner before proceeding with splices.
3. If splices are required and approved by Owner, the wire shall be joined with solder, then taped or otherwise protected in an approved manner so as to provide mechanical and electrical integrity. Wire nuts and/or electrical tape connections shall not be acceptable. Final connections shall be made at terminal boards with full tagging, labeling and documentation.
4. Water-resistant protection shall be continuous throughout the cable in parking areas, surface conduit, poles, in-slab pull-boxes, in-slab conduit, and underground conduit and pull-boxes, and in any areas subject to moisture and/or water infiltration:
  - a. Splices/Junctions: Provide water-proof protection of splices and junctions, in surface conduit and boxes, in-slab conduit and pull-boxes, underground conduit, and underground pull-boxes, to prevent the entry of moisture or water into cables, splices, or connections.
  - b. Cable Entries: Provide water-blocking sealants at all conduit entries into pull-boxes, junction boxes, back-boxes, cabinets, etc., to prevent the entry of moisture or water into the conduit and cable system.

- D. Boxes: Provide a box loop for wire and cable routed through pull boxes or controller panels. Cable loops and bends shall not be at a radius less than that recommended by the manufacturer. Coordinate pull box size with the Division 26 Contractor as necessary to accommodate this requirement.



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- E. Wire Lacing and Dressing: Dress, lace, tie or harness wire and cable vertically, horizontally and at right angles to the enclosure surfaces to prevent mechanical stress on electrical connections as required herein and in accordance with accepted professional practice. No wire or cable shall be supported by a connection point.
- F. Non-Coaxial Connections: Make non-coaxial connections and approved splices within terminal cabinets (except microphone or line level) to screw-type barrier blocks with insulated crimp- type spade lugs. Size all lugs properly to assure high electrical integrity. Connect only one (1) wire per spade lug and not more than two (2) lugs per screw terminal.
- G. Non-Coaxial splicing at device locations to equipment with wire leads shall be made with pre-approved wire Dolphin Connectors.
- H. Shielded Cables: Shielded cables shall be insulated. Do not permit shields to contact conduit, raceway, boxes, terminal cabinets, or equipment enclosures. Tin terminated shield drain wires and insulate with heat shrinkable tubing.
- I. Coaxial Splices: Coaxial splices, if required and approved, shall be on plate mounted dual- barrel type insulated BNC connectors, secured in such a manner that no stress is placed upon the connector.
- J. Unacceptable Conditions: Correct any unacceptable wiring conditions immediately upon discovery, and upon receiving notice to correct.

3.15 DATABASE PREPARATION, CHECKING AND ACTIVATION

- A. Contractor to request Owner provided forms with completed nomenclature for each identified device no less than 30 days prior to programming. It is essential that the above activities be clearly identified on the Project Schedule, so database preparation is accomplished in sufficient time to permit orderly and on time system activation
- B. It shall be the responsibility of the Owner to insure the accuracy of the database information entered on forms by thoroughly checking completed data entry forms.
- C. It shall be the responsibility of Contractor to ensure that the database formatting is correct prior to entry into the system and system activation.
- D. Programming
  - 1. The Contractor shall be responsible for the initial database entry for devices and equipment installed in this project into the existing system prior to activation. Location of program database entry to be confirmed with the Owner. The database shall consist of hardware and function-related information, i.e., system configuration, doors, alarm points, software parameters for system management, graphical maps, intercom interfaces, alarm information – access levels, automatic opening and locking schedules. A printout of the final database shall be provided to the Owner for review and approval prior to system activation.



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2. Programming rights shall be provided the Owner. Contractor shall coordinate with the Owner prior to the completion of installation to set a schedule for access to programming resources.
  3. Follow all procedures and protocols for programming the system, in accordance with Owner instructions.
- E. System activation shall be the responsibility of Contractor. Once the system and database have been demonstrated to be functioning properly according to manufacturer's guidelines and the system design, further database entries and upgrades shall be the responsibility of Owner, unless otherwise noted.

3.16 SOFTWARE UPGRADES

- A. If more recent versions of the operating system or application software are made available to or requested by the Owner prior to system acceptance, these updated versions shall be installed and verified by Contractor.
- B. Before installing upgrade software, Contractor shall ensure that existing database information is properly "backed-up" prior to any installation action. 3

3.17 START-UP RESPONSIBILITY

- A. Contractor shall initiate System Operation. Competent start-up personnel shall be provided by Contractor on each consecutive working day until the System is functional and ready to start the acceptance test phase. If in Owner's judgment Contractor is not demonstrating progress in solving any technical problems, Contractor shall supply Manufacturer's factory technical representation and diagnostic equipment at no cost to Owner, until resolution of those defined problems. Where appropriate, Contractor will bring the System on-line in its basic state (i.e., alarm reporting, facility code access control, etc.).
- B. Properly ground each piece of electronic equipment prior to applying power.
- C. Properly ground all shielded wire shields to the appropriate earth ground at the hub end only, not at the remote or device end.
- D. Use a start-up sequence that incrementally brings each portion of the system on-line in a logical order that incorporates checking individual elements before proceeding to subsequent elements until the entire system is operational.

3.18 PRELIMINARY, INSPECTION, ACCEPTANCE TESTING, AND COMMISSIONING

- A. Provide Preliminary Testing, Inspection, Acceptance Testing, Burn-In and Commissioning Performance services for systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.



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3.19 FINAL PROCEDURES

- A. Portable Equipment: Furnish portable equipment specified herein to the Owner, along with complete documentation for the materials furnished. Portable equipment shall be presented in the original manufacturer's packing, complete with manufacturer's instructions, manuals and documents. Testing of portable equipment shall have been previously conducted by the Contractor.
- B. Post Acceptance Work: Check, inspect and adjust systems, equipment, devices, and components specified, programming updates, at the Owner's convenience, approximately sixty (60) days after Acceptance of the Installation.

3.20 NOTICE OF COMPLETION

- A. When the performance and acceptance requirements described above, including the Final Acceptance Test, have been satisfactorily completed, the Owner shall issue a Letter of Completion to Contractor indicating the date of such completion. The Notice of Completion shall be recorded by Contractor upon receipt of the Owner completion letter. This date of record shall be the start of the warranty period.

**END OF SECTION 28 00 00**



## **SECTION 28 13 00 - ACCESS CONTROL AND ALARM MONITORING SYSTEM**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2 SUMMARY:**

- A. Work Included: The Work of this Section includes, but is not limited to the following:

1. Access Control System hardware
2. Access Control System software
3. All necessary Access Control System and OS software Licenses
4. Access Control System power supplies and accessories
5. Workstations for managing and monitoring the system
6. Intercom System
7. ACS Software installation and configuration
8. OS software installation and configuration for all PC and Servers
9. Staff Training
10. System Administration
11. System Operator
12. The supply and installation of system cabling, as needed excluding Ethernet cabling
13. The termination of system cabling, as needed excluding Ethernet cable
14. Identification and labeling of all system cables
15. Testing of all devices and cables
16. Providing as-built drawings
17. Providing test results

#### **1.3 ACCESS CONTROL SYSTEM DESCRIPTION**

- A. The new Access Control System consists of security equipment such as controllers; multi-Class smartcard readers, egress devices, magnetic door contacts, duress alarms and power supplies that are used to control access to secured areas.
- B. Access control will be provided on selected doors.
- C. All ACS equipment on a floor will be wired back to Access Control Panels located in telecommunication rooms.



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- D. The door access system is to be controlled remotely and integrated to the existing system located at City Hall.
- E. Communications for the Access Control Panels shall be by TCP/IP over the Local Area Network. Security will have its own VLAN (SVLAN) connection furnished by the others.
- F. The ACS panels will contain intelligence for standalone operation of access control functions in the event of loss of communications between the panel and peer panels.
- G. Contractor will be required to connect and utilize the existing database for the Owner's entire staff. This includes but not limited to:
  - 1. Time Schedules
  - 2. Access levels for employees
  - 3. Access groups
  - 4. User level data
  - 5. Report Templates
  - 6. System Administration Levels
  - 7. Data Entry of all Owner's Employees
  - 8. Other attributes as specified by Owner.
- H. Where indicated the access control system shall use multi-class smartcard readers. General Contractor (GC) shall be responsible for ensuring that all doors receiving access control security equipment are aligned properly, have the necessary door closing equipment, and also operate properly.
- I. GUI maps shall be developed to show door alarms and camera call ups.
- J. The access control system shall be seamlessly integrated with the IP Video surveillance system for camera call ups on alarm.
- K. The access control system will be monitored in the security command center via workstations.
- L. Coordination will be required with door hardware contractor on interfacing the access control system with doors that have auto operators. An authorized credential read shall allow for the auto operator button to be activated. Auto operator will open the door only by the paddle on the wall being pushed.
- M. Elevators will have readers as designated on the drawings. Installation of the readers and control of the elevators will require coordination with the elevator contractor. All card readers located at the interior of an elevator cab shall be terminated in the elevator machine room.
- N. Commissioning of components, equipment and/or system specified in this division is part of the construction process. Documentation and testing of these components, equipment and/or system, as well as training of the Owner's operation and maintenance personnel on these components, equipment and/or system, is required in cooperation with the Owner's Representative and Commissioning Agent. Project



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Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to section General Commissioning Requirements - Section 01 91 13, for detailed commissioning requirements.

1.4 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. The following is not included in this Section:

1. Conduit
2. Raceways
3. Back boxes
4. Grounding and bonding cables
5. Sleeves
6. Plywood backboards
7. Electrical power
8. Fire Alarm Relays
9. Grounding Busbar
10. NEMA enclosures
11. Patch Panels
12. Category 6 or 6A cables and terminations
13. Fiber optic Cables and terminations
14. Installation of communications equipment.

1.5 VERIFICATION OF FOOTAGES AND ROUTING

A. Contractor shall be responsible for final routing of all cables and/or conduits.

1.6 QUALITY ASSURANCE

- A. All equipment provided by the Contractor shall be new and shall meet or exceed the latest published specifications of the manufacturer in all respects.
- B. Contractor to provide the latest model/revision of a specified piece of equipment, at the time of installation.
- C. Obtain detailed instructions for installation from manufacturer of each product.

1.7 SUBMITTALS

A. Pre-Construction

1. Product cut sheets for all products and materials.
2. Recommended application and installation methods.
3. Drawings showing device locations and types, riser diagrams, wiring diagrams, approvals, test data.



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4. Complete shop drawings of all custom-fabricated or assembled products, including wiring diagrams.
5. Drawings identifying all terminals and illustrating all device wiring connections.
6. Elevations and detailing plans.
7. Operating instructions.

B. Post Construction

1. As-Built Documents
2. All preconstruction shop drawings updated to as-build condition.
3. Product cut sheets for all equipment used.
4. Operating manuals.
5. Warranty information.

1.8 APPROVALS

- A. Obtain all necessary approvals and permits from Local Authorities, for all materials to be supplied, methods of installation and system operations, as required herein and by the Local Authorities.
- B. The entire installation, including materials and equipment shall meet or exceed the minimum standards and requirements of the following:
  1. Underwriters' Laboratories, Inc. listing service.
  2. NFPA 72 and National Fire Codes.
  3. Codes as accepted and/or modified by the local Authorities:
    - a. National Electrical Code.
    - b. American Disabilities Act (ADA).
    - c. Underwriters' Laboratories, UL 1971 for Hearing Impaired.

1.9 SERVICE SUPPORT

- A. The Contractor shall maintain a factory trained staff capable of performing all necessary support tasks.
- B. The Contractor shall have a 24-hour service staff located within a 100-mile radius of the project site.
- C. The service/organization shall have a minimum of 5 years' experience with similar types of systems and equipment.
- D. Response time for service shall be on a timely basis. Phone contact shall occur within one hour. After receipt of service request, on-site service shall occur within 24 hours.



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1.10 WARRANTY

- A. The Security Systems described herein shall carry a warranty covering parts and labor for a period of one (1) full year from the date of substantial completion.
- B. During the warranty coverage, there shall be two (2) preventative maintenance checks which include software updates, inspection of all components, fine adjustments and repairs as required.

PART 2 - PRODUCTS

2.1 CARD READER

- A. Card reader shall be multi-class smartcard readers.
- B. Card readers must be compatible with the existing Lenel Access Control System used throughout the Owner's campus.
- C. Readers shall be installed in accordance with manufacturer instructions and electrical code, to include not mounting reader directly on metal.
- D. The contractor shall provide 2 spare of these card readers.
- E. Card readers will be located in locations specified by the construction drawings
- F. Where indicated, provide with integrated keypad.
- G. Approved Manufacturer:
  - 1. HID Signo Reader 40 (without keypad).
  - 2. HID Signo Reader 40K (with keypad).

2.2 SECURITY CONTROL PANEL

- A. All access control panels shall be IP addressable.
- B. Loss of communication and panel tamper must generate unique event indicating the device affected.
- C. Access control door controller modules shall be installed in a lockable cabinet above each door. All door security devices (card reader, door contact, request to exit, lock, etc.) shall be connected to the door controller module.
- D. Door controller modules shall be connected to the Owner's network via a data drop provided by the telecommunications contractor.



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- E. Intelligent access control panels shall be wall mounted and located in IT rooms. Intelligent access control panels shall be connected to the Owner's network via a data drop provided by the telecommunications contractor.
  - 1. Access control panels that control the elevators can be mounted in the elevator control room. A data drop will be provided by others in the elevator control room to connect to the SLAN. These should be the only panels outside of the IT room, unless approved by the security consultant or Owner.
- F. Approved Manufacturer:
  - 1. Door Controller Module: DMP
  - 2. Intelligent Access Control Panel: DMP

## 2.3 WORKSTATION

- A. Security workstations shall be provided by Owner.
- B. Security Contractor shall coordinate installation of access control software on Owner provided workstations as required.

## 2.4 SOFTWARE

- A. The doors will be configured to represent door forced, door held, access granted, and access denied status and any off normal conditions.
- B. Software to be provided with the latest upgrade so its compatible with the current system at City Hall.
- C. Any Additional licenses or software needed to realize the capability provided in this document shall be provided by the integrator.
- D. Provide software licenses for integration of the IP Video surveillance system.
- E. Any software that is used in the configuration or operations of the system shall be provided to the Owner's Security Team on electronic media format.
- F. A system backup of the system database and other configuration files shall be provided in electronic format to the Owner's Security Team.
- G. System shall be configured to automatically backup the ACS database on a periodic basis. The frequency will be determined by the Owner's Security Team.
- H. All system user accounts and passwords will be documented and provided to the Owner's Security Team in electronic and paper format.



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I. The video surveillance system shall report to the Lenel Access Control Software to manage video systems and cameras, along with integrated alarms with the Access Control System.

J. Approved Manufacturer:

1. DMP

## 2.5 DOOR POSITION SWITCH

A. Steel doors shall have recessed door position switches.

1. Door position switches shall be 3/4" diameter with wire leads.
2. Approved manufacturer:
  - a. Magnasphere model MSS-19C
  - b. Approved equivalent

B. Glass doors shall have recessed door position switches.

1. Door position switches shall be 3/8" diameter with wire leads.
2. Approved manufacturer:
  - a. GE/Sentrol model R1125
  - b. Approved equivalent

## 2.6 OVERHEAD DOOR CONTACT

A. Shall use a 3-foot stainless steel armored cable.

B. The overhead contact shall be floor mounting, extra heavy duty.

C. Overhead door contacts will be located at the locations specified on the construction drawings.

D. Approved manufacturer

1. GE/Sentrol model 2200 Series
2. Approved equivalent.

## 2.7 DOOR EXIT BUTTON

A. Push to exit devices will be required on all magnetic lock doors.

B. The push to exit device shall have a momentary double pole double throw switch.

C. The push to exit device shall be pneumatic to allow an adjustable time delay between pushing the button and exiting the door.



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- D. Activating the push to exit device must break power from the associated door, as well as send a signal to the nearest access control panel with an event unique to that door.
- E. The push to exit device shall mount to a single or double gang box.
- F. The push to exit device shall be installed to comply with all local and national codes.
- G. Approved manufacturer:
  - 1. ASSA ABLOY/Alarm Controls TS-14
  - 2. Or approved equivalent

2.8 REQUEST TO EXIT (REX)

- A. Provide request-to-exit (REX) integrated into the lockset.
- B. Approved manufacturer
  - 1. Manufacturer: Coordinate with Door Hardware specifications
  - 2. Approved equivalent.

2.9 POWER SUPPLIES

- A. Power supplies for the locks shall be 24 VDC.
- B. Power supply shall be centrally provided from the telecom rooms and must be rack mountable.
- C. Approved Manufacturer
  - 1. Altronix
  - 2. Approved equivalent.

2.10 BATTERY BACKUP

- A. Battery backup shall be provided for all access control panels and lock power supplies.
- B. There shall be 2 hours of battery backup for each access control panel and lock power supply.
- C. Approved manufacturer
  - 1. Altronix model BT1212
  - 2. Approved equivalent.



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2.11 GLASS BREAK DETECTION UNITS

- A. Glass break sensors shall be ceiling mounted at the approximate locations as shown on the drawings.
- B. Contractor shall coordinate exact locations of glass break sensors as local conditions permit to ensure all large windowed areas are within sensor detection coverage.
- C. Sensors shall be connected to the intrusion detection panel and generate an alarm condition upon the detection of glass breaking.
- D. Minimum Specifications:
  - 1. Detection technology: Acoustic
  - 2. Coverage: 25' minimum radius
  - 3. Output contact: Normally closed (NC) powered non-alarm / trouble state
  - 4. Listings: UL Listed as Breakage Detector
  - 5. Power requirements: 12 - 24 VDC
  - 6. Mounting: Surface or Flush, Wall or Ceiling as required
- E. Acceptable Manufacturers
  - 1. Bosch DS1101i Series Glassbreak Detector
  - 2. Or approved equivalent

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All cables labels shall be machine printed heat shrink type. Handwritten labels are not acceptable. Labels shall indicate device number and destination. Labels shall be located on both ends of each cable.
- B. Install and dress all devices wiring neatly.
- C. At the telecom rooms and MDF, install all appropriate access control system equipment in such a manner that all control functions on the front of each unit shall be accessible. All cable connections shall be made from the rear of the units.
- D. Install the access control system workstation and all peripheral equipment.
- E. At each System Controller location, install auxiliary equipment, power supplies, field panels and all other appropriate access control system equipment.
- F. Install access control system field devices, including card readers, panic buttons, and door contacts in accordance with the manufacturer's instructions and



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recommendations. Assure all devices maintain signal continuity throughout entire system.

- G. Install all devices in accordance with the manufacturer's instructions and recommendations. Assure all devices maintain signal continuity throughout entire system.
- H. The Contractor shall provide the connection of the console racks to the power outlet.

### 3.2 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner and/or Owner's Representative. Provide competent, factory authored personnel to provide instruction to operation and maintenance personnel concerning the location, operation and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner and/or Owner's Representative after submission and approval of formal training plans. Refer to section Demonstration and Training - Section 01 79 13, for training requirements. Refer to section General Commissioning Requirements -Section 01 91 13, for further training requirements.
- B. Vendor shall supply two (2) printed sets and two (2) electronic copies on a CD/DVD of an Operations Manual for the system. Manual must show all instructions, commands, screen shots and functions used in the course of operating the ACS system in a normal or off-normal condition.
- C. Vendor shall supply two (2) printed sets and two (2) electronic copies on a CD/DVD of an Administration Manual for the system. Manual must show all instructions, commands, screen shots, and functions used to administer the ACS software and hardware.

### 3.3 CERTIFICATION

- A. Security contractor shall include a letter of certification from the access control manufacturer with their submittal.
- B. Security contractor shall include a letter of certification from the intercom manufacturer with their submittal.

### 3.4 TESTING

- A. After work is completed, and prior to requesting the Acceptance Test, Contractor shall conduct a final inspection and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.



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- B. Contractor shall submit a request for the Acceptance Test in writing to the Owner using an approved "Request for Security Systems Acceptance Test" form, a copy of which will be provided.
  - 1. This request shall be submitted to the Owner no less than 7 days prior to the requested test date.
  - 2. The request for Acceptance Test shall constitute a certification from Contractor that all work is complete and in compliance with the Contract Documents, Manufacturer installation specifications, that all systems have been tested, and all corrections have been made.
- C. Acceptance Test shall be scheduled during a period when the building is unoccupied, and a complete system test can be accomplished.
- D. Contractor shall provide the services of no fewer than 2 technicians to perform the Acceptance Test.
  - 1. Technicians performing the Acceptance Test shall have been involved in the installation of this project and shall be thoroughly familiar with all aspects of the work.
  - 2. Technicians shall be equipped with portable two-way radios or cell phones for use during the test.
- E. Contractor shall provide all ladders, tools, test equipment, and other facilities needed to accomplish the Acceptance Test.
- F. During Acceptance Test, Contractor shall demonstrate all equipment and system features to the Owner.
  - 1. Contractor shall fully cooperate with the Owner and provide assistance with the inspection and test.
  - 2. Contractor shall remove and reinstall covers, open and restore wiring connections, operate equipment, and perform other reasonable work as requested by the Owner during the Acceptance Test.
- G. Any portions of the work found to be deficient or not in compliance with the Contract Documents will be rejected.
  - 1. The Owner will prepare a list of any deficiencies observed during the Acceptance Test.
  - 2. A copy of this list will be provided to the Contractor, who will promptly correct all deficiencies.
- H. Should the systems not be ready for testing by the Consultant at the date(s) and time(s) indicated by the Contractor, system acceptance testing may be rescheduled at the sole discretion of the Consultant. The Contractor shall pay for the labor and expenses of the Consultant and other project team members assembled at the project site for the purpose of system acceptance testing for the date(s) of the original of the scheduled testing plus the labor and expenses of the Consultant and other project



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team members for the rescheduled testing date(s). The labor rate for the Consultant shall be a flat rate of \$200.00/hour including travel time. Other project team member labor costs shall be at their respective published rates. The PM and/or Owner shall be entitled to deduct any money owing to the Owner, PM, Consultant, or other project team members under this contract from any sum which may become due or is payable to the Contractor under this Contract for the purposes of satisfying the charges listed above

- I. These requirements are in addition to the Commissioning and Functional Performance Testing requirements and references to Division 01 General Commissioning Spec.

**END OF SECTION**



## **SECTION 28 16 00 - INTRUSION DETECTION SYSTEM**

### **PART 1 - GENERAL GUIDELINES**

#### **1.1 GENERAL**

- A. This Section defines the general design requirements for a uniform Intrusion Detection System that shall be followed for all Technology construction projects.
- B. Refer to Sections 27 00 00 Technology Systems, 28 13 00 Access Control System and 28 23 00 Video Surveillance System for additional information.

#### **1.2 SECTION INCLUDES**

- A. Intrusion Detection System.
- B. Uninterruptible Power Supply (UPS).

#### **1.3 QUALITY ASSURANCE**

- A. National Fire Protection Association.
- B. NFPA 730 – Guide for Premises Security
- C. NFPA 731 – Standard for the Installation of Electronic Premises Security Systems
- D. National Electric Code.
- E. American with Disabilities Act.
- F. Underwriter's Laboratory.
- G. Latest ANSI TIA/EIA-568, 569, 606, 607 Standards and Eleventh Edition (or later).
- H. BICSI Telecommunications Distribution Methods Manual (TDMM).
- I. UL 1610 -- Central-Station Burglar-Alarm Units.
- J. UL 1023 -- Standard for Safety Household Burglar-Alarm System Units.
- K. UL 609 -- Standard for Safety Local Burglar Alarm Units and Systems.
- L. UL 365 -- Standard for Safety Police Station Connected Burglar Alarm Units and Systems.



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- M. UL 985 -- Household Fire Warning System Units.
- N. Products -- Factory Mutual approved.

1.4 SYSTEM WARRANTY

- A. The Intrusion Detection System and software shall be fully warranted for three (3) years from date of substantial completion by the contractor and manufacturer. If any defects are found within this warranty period, the defective system component shall be replaced at no extra cost to the Owner for parts or labor. Provide a statement of this warranty with the O&M manuals and to the Director of IT. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

1.5 SYSTEM OPERATION

- A. Upon entering a valid access code via a system control keypad, the system shall disarm the applicable zones, disarm the alarm system, and log the transaction pertaining to time, date, and user.
- B. The Intrusion Detection System shall provide the following functions:
  - 1. A system control panel, control keypads, magnetic door contacts, motion sensors, and alert sirens.
  - 2. Provide interconnection to the District provided dedicated telephone connection for monitored response to after-hours alarms. Consider cellular backup system.
  - 3. Provide interconnection to the central control panel for monitoring all applicable doors with door contacts.
  - 4. System shall be fully integrated with the building's Access Control and CCTV System.
  - 5. The System shall be integrated with the building lighting system and shall activate the corridor lights and other selected areas in the event of alarm activation.
  - 6. The System shall be supervised, i.e. power failure, line cuts and communication failures shall signal the monitoring station(s) of the problem.
  - 7. The fire system flow and tamper points shall be attached to the system.
  - 8. The System shall provide monthly reports, detailing as a minimum:
    - a. Alarm System usage.
    - b. Door Openings.
    - c. Door Closings.
    - d. Alarm Conditions.
- C. The System shall be programmed to accept individual access codes from authorized employees. Codes shall not be shared.



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1.6 EXTERIOR ENTRANCE / EXIT DOOR

A. KEYPAD

1. A keypad shall be mounted within six (6) feet of the entrance on the inside of the facility.
2. The keypad shall utilize a minimum of a two (2) line, 32-character LCD display and an integral multi-tone speaker.
3. The keypad shall contain an internal diagnostics program allowing for system troubleshooting without disabling the system.
4. The keypad shall allow for the use of three dedicated keys to function as panic keys.
5. Keypads shall have a keypad activated duress code feature.
6. All keypads shall be interfaced with the Control Panel.

B. DOOR CONTACT

1. A magnetic door contact switch shall be installed at each exterior door to provide door open/closed status to the system.
2. The contact switch shall be installed recessed into the doorframe where applicable.

C. CENTRAL CONTROL PANEL

1. Provide one Central Control Panel, which shall be equipped with a lock and transparent door panel.
2. The Central Control Panel shall provide the required input zones, operate on 24V D.C., indicate ground fault, and activate audio and visual devices.
3. The Central Control Panel shall have a battery charging system and battery(s).
4. Connect the Central Control Panel to the Main Equipment Room, generator powered, UPS Units.
5. Provide necessary auxiliary contacts (alarm and trouble), for sending signals to the digital communication system.
6. Provide necessary auxiliary contacts to power the exterior bell.
7. The Central Control Panel shall provide a telephone digital communication actuation and supervisory circuit.
8. Connect Central Control Panel to the District provided telephone line(s).

1.7 P.I.R. MOTION SENSOR

- A. The Technology Vendor shall verify requirements of motion sensors with the College.
- B. The system type shall be passive infrared motion detectors.
- C. The sensors shall be microprocessor controlled and contain a false alarm protection feature.



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- D. The sensors shall provide a minimal coverage pattern of 50 feet by 50 feet to 120 feet by 12 feet based on interchangeable lenses. Select lenses based on coverage area required.
- E. Short, medium and long-range motion detectors shall be selected as required to suit the area to be covered.
- F. The sensors shall be capable of mounting either on a ceiling, wall surface or in a corner.
- G. Consider sensor installations on all floors of the facility, in corridors and all rooms with outside access.
- H. Consider each entry point backed up by Motion Detectors.
- I. Consider motion detectors in computer labs.
- J. Locate motion detectors to provide full coverage and minimize false alarms.
- K. Provide single or dual technology motion detectors based on application.
- L. Dual Technology sensors shall employ both Microwave and Passive Infrared.

1.8 ALARM SIREN

- A. The system shall be provided with an external alarm siren(s) (horn) and strobe light as required.
- B. The alarm sirens and strobes shall be housed in a tamper proof, weather resistant metal enclosures.

1.9 INSTALLATION

- A. The system wiring and installation shall comply with all applicable codes and drawings and shall be installed in accordance with the manufacturer's recommendations.
- B. All wiring shall be color-coded and labeled at each end with self-laminating, machine printed labels.
- C. All wiring shall be installed in metallic raceways and shall comply with the latest edition of the National Electric Code (NEC).

1.10 MOUNTING HEIGHTS

- A. All mounting heights shall comply with the Americans with Disability Act (ADA).



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- B. Mount Motion Detectors to provide maximum coverage, and minimal false alarms. Do not obstruct viewing angle.

#### 1.11 TRAINING

- A. Provide a minimum of four (4) hours training on the operation of the system.
- B. Provide a digital video copy of all training.

### PART 2 - PRODUCTS

#### 2.1 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Description: Hard-wired, modular, microprocessor-based controls, Full (complete) coverage intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions. Technology Vendor shall use “Bosh” manufacturer product per SBCCD Standards.
- B. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
  - 1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
  - 2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
  - 3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.
- C. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.
- D. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.
- E. Operator Commands:
  - 1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
  - 2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.



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3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
  4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
  5. Protected Zone Test: Initiate operational test of a specific protected zone.
  6. System Test: Initiate system-wide operational test.
  7. Print reports.
- F. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
- G. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.
- H. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED.
- I. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.
- J. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

## 2.2 SYSTEM COMPONENT REQUIREMENTS

- A. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:
1. Door hardware specified in Section 08 71 00 "Door Hardware with Door Numbers."
  2. Access control system specified in Section 28 13 00 "Access Control." 3.  
System must be compatible with "ADT" remote monitoring service provider.
- B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.



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1. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.
- C. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.
- D. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.
- E. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.
- F. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.

## 2.3 ENCLOSURES

- A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.
- B. Interior Electronics: NEMA 250, Type 12.
- C. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

## 2.4 SECURE AND ACCESS DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by Bosch Security Systems, Inc.
- B. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

## 2.5 DOOR AND WINDOW SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Bosch Security Systems, Inc. Model; ISN-CTC75
  2. Inerlogix United Technologies. Model; 1078/1076 series



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- B. Description: Double Pole Double Throw DPDT, Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.
- C. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.

## 2.6 PIR TECHNOLOGY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products Bosch Security Systems, Inc.
  - 1. PIR Detector Model ISC-PPR1-W16
- B. Description: PIR detector designed for commercial indoor applications. The unit shall consist of a self-locking two-piece enclosure with a built-in two-way bubble level to help simplify the installation. The detector shall incorporate 1) sensor data fusion technology to ensure that the detector sends alarm conditions based only on precise information and 2) tri-focus optics technology to eliminate coverage gaps.
- C. Listed and labeled by a qualified testing agency for compliance with the following standards and approvals:
  - 1. UL 639 and cULus
  - 2. CE
  - 3. C-Tick
  - 4. EN50131-1 Grade 2
- D. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.
  - 1. The detector specified shall provide active white light suppression capable of measuring the light intensity directed at the face of the unit and use the data gathered by the sensors to eliminate false alarms caused by the bright light source. False alarms shall not be caused from bright light sources up to 10,000 lux.
  - 2. The detector shall provide the following DIP switch selectable fields of coverage:
    - a. 16 m x 21 m (50 ft x 70 ft)
    - b. 8 m x 10 m (26 ft x 33 ft)
  - 3. The detector shall be designed to be mounted at a height between 2.1 m to 3m (7 ft to 10 ft) and require no adjustments.
  - 4. The detector shall provide dynamic temperature compensation that adjusts the PIR sensitivity to identify human body heat accurately at critical temperatures to avoid false alarms and deliver consistent catch performance at all operating temperatures.



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5. The detector shall provide a cover and wall tamper switch with a normally- closed contact that opens to notify the control panel in the event the cover is removed, or the detector is separated from the wall. The contacts shall be rated at 25 VDC, 125 mA maximum.
  6. The detector shall contain a blue light emitting diode (LED) that adjusts automatically to the surrounding light level. The LED indicates alarms and will activate during a walk test.
  7. The walk test LED may be enabled or disabled via a command from the control panel, or it may be enabled or disabled using the local DIP switch of the detector.
  8. The detector shall provide a solid state relay that is power supervised and uses less current and provides longer standby capacity than a mechanical relay. The solid state relay shall be used to send a silent alarm output signal. Rating of the relay shall be 3W, 125 mA, 25 VDC, with resistance less than 10 ohms.
  9. The detector shall reduce false alarms by having a sealed optic chamber that provides immunity to drafts and insects.
- E. Mounting Brackets: The manufacturer shall offer the following three optional mounting brackets.
1. A Gimbal-mount bracket [Bosch B328] that mounts on a single-gang box and allows rotation of the detector.
  2. A Low-profile plastic wall swivel mount bracket [Bosch B335-3]. The mount allows a vertical pivot range of  $+10^{\circ}$  to  $-20^{\circ}$  and a horizontal pivot range of  $\pm 25^{\circ}$ .
  3. A plastic universal swivel bracket for ceiling mounting [Bosch B338]. The mount allows a vertical pivot range of  $+7^{\circ}$  to  $-16^{\circ}$  and a horizontal pivot of  $\pm 45^{\circ}$ .

## 2.7 MASTER CONTROL UNIT

- A. Manufacturers: Subject to compliance with requirements, provide Bosch Security Systems, Inc.; D9412GV4 with D1260 series LCD keypads.
- B. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.
1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
  2. Include a real-time clock for time annotation of events on the event recorder and printer.
  3. Addressable initiation devices that communicate device identity and status.
- C. Construction: Modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable. D. Comply with UL 609.



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- D. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: LCD, two line(s) of 40 characters, minimum.
  2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
  3. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
  4. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
  5. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:
    - a. Acknowledge alarm.
    - b. Silence alarm.
    - c. System reset.
    - d. LED test.
  6. Timing Unit: Solid state, programmable, 365 days.
  7. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
  8. Alarm Indication: Audible signal sounds and an LED lights at master control unit identifying the protected zone originating the alarm. Annunciator panel displays a common alarm light and sounds an audible tone.
  9. Alarm activation sounds multiple sirens and strobes.
- E. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.
- F. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load. H. UPS: UPS shall be sized to provide a minimum of six hours of master control-unit operation.
- G. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin



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nameplate. Lettering on enclosure nameplate shall not be less than 1 inch (25 mm) high. Identify, with permanent labels, individual components and modules within cabinets.

- H. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to minimum of four off-site monitoring stations, operating over a standard voice grade telephone leased line or IP network connection. Comply with UL 1635.

## 2.8 AUDIBLE AND VISUAL ALARM DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Alarm Controls Corporation.
  - 2. Cooper Wheelock.
  - 3. Edwards Signaling & Security Systems; part of GE Security.
  - 4. Honeywell International Inc.; Honeywell Security.
  - 5. Potter Electric Signal, LLC.
- B. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at 10 feet (3 m) from master control unit.
  - 1. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.
- C. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.
  - 1. Light Output: 115 cd, minimum.
  - 2. Flash Rate: 60 per minute.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.



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- D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.
  - 1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
  - 2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.
- E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 SYSTEM INTEGRATION

- A. Integrate intrusion detection system with the following systems and equipment:
  - 1. Electronic door hardware.
  - 2. Access control.
  - 3. Lighting Controls
    - a. Comply with requirements for lighting controls system integration specified in 260943.23 "Relay-based Lighting Controls". Provide all relays or dry contacts inputs to the lighting controls panel and required programing to turn lights on or off as described in that section.

### 3.3 SYSTEM INSTALLATION

- A. Comply with UL 681 and NFPA 731.
- B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
  - 1. Comply with requirements for seismic-restraint devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

### 3.4 WIRING INSTALLATION

- A. Wiring Method: Install wiring in metal raceways according to Section 26 05 33 "Raceways and Boxes for Electrical Systems." Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.
- B. Wiring Method: Install wiring in metal raceways according to Section 26 05 33 "Raceways and Boxes for Electrical Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum



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conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

- C. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Wires and Cables:
  - 1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
  - 2. 120-V Power Wiring: Install according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
  - 3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 28 05 13 "Conductors and Cables for Electronic Safety and Security."
  - 4. Data and Television Signal Transmission Cables: Install according to Section 28 05 13 "Conductors and Cables for Electronic Safety and Security."
- F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- G. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.
- H. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

### 3.5 IDENTIFICATION

- A. A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 26 05 53 "Identification for Electrical Systems." B. Install instructions frame in a location visible from master control unit.



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3.6 GROUNDING

- A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.
- B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.
- D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
  - 1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."
  - 1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
  - 2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table
- D. "Test Methods" and Table "Test Methods of Initiating Devices."
- E. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."



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- F. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.

3.9 DEMONSTRATION

- A. A. Train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

**END OF SECTION 28 16 00**



## **SECTION 28 23 00 - VIDEO SURVEILLANCE SYSTEM**

### **PART 1 - GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Applicable requirements of Division 28 - Electronic Security shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to furnishing and installing Video Surveillance System.
- C. All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Contractor as detailed in this document.
- D. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements for the system(s) described in this document and on the drawings.
  - 1. Video Surveillance system shall be compatible and integrated with the components specified in:
    - a. Section 28 00 00 - Electronic Security
    - b. Section 28 13 00 - Access Control System
    - c. Section 28 16 00 – Electronic Intrusion Detection System

#### **1.2 SUBMITTALS**

- A. Provide product data from manufacturer's specifications.

#### **1.3 WORK INCLUDED**

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this system. The Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the specification or not.
- B. The work shall include, but not be limited to the following:
  - 1. Furnish and install a complete video surveillance system.
  - 2. Furnish and install all cameras, lenses, housings, and mounting devices.
  - 3. Furnish and install all network video recorders.
  - 4. Furnish and install all work stations and monitors.



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5. Furnish and install all PoE switches.
6. Furnish and install all UPSs.
7. Furnish and install all system cabling. (IP/Ethernet/Network Cabling by Division 27 contractor)
  - a. Provide lightning and surge protection where cabling leaves building perimeter
8. Furnish and install all equipment cabinets.
9. Furnish and install all cabling.
10. Furnish any other material required to form a complete system.
11. Perform testing of all components.
12. Furnish test results of all cabling to the Owner on disk and paper format.
13. Provide Owner training and documentation.
14. Verify all AC power requirements for all systems and components. Confirm AC voltage and frequency of all systems and components match the facility power distribution system. Coordinate the above with Electrical Contractor.

1.4 RELATED SECTIONS:

- A. Section 28 00 00 Electronic Security
- B. Section 28 08 00 Security Testing and Commissioning
- C. Section 28 16 00 Electronic Intrusion Detection

1.5 TECHNICAL REQUIREMENTS, VIDEO SURVEILLANCE SYSTEM

A. General

1. The following information is provided to establish required system performance for the complete operating Video Surveillance System (VSS) system expansion to the Santee Community Center system. Some of the performance requirements noted herein are supported and supplied by existing systems in concert with new equipment and software which shall be provided by the Contractor under this scope of work. Contractor shall provide equipment, wiring and software programming at all sites as necessary to provide a complete system as described herein and as shown on the drawings.
2. The VSS components provided under this scope of work shall be compatible with the existing VSS and shall function as an integral part thereof. The existing enterprise-wide network video system is manufactured by Digital Watchdog.
3. Contractor shall be responsible for providing equipment, licenses and software to achieve the specified system performance described herein and, by reference, realize absolute and seamless compatibility with the existing system.
4. Contractor shall ensure system additions and modifications provided under this scope of work have no negative effect on the existing systems and operations, and no permanent effect beyond that specified or implied by the scope of work unless otherwise noted herein.



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B. Purpose

1. The System shall provide the ability to record images received from cameras located throughout Santee Community Center facilities in a digital format.
2. The System shall allow operators to view live and recorded video images in single and multiple-camera formats based on parameters requested by the user.

C. Environment

1. The system shall be wholly contained within the Building facilities shown on the plans but shall also be fully integrated with the Owner's enterprise video surveillance systems (VSS) at the Security Operations Center (SOC). Refer to the drawings and Bid Instructions to determine the scope limitations for this phase of work.
2. Video Processing and Recording Components (Network Video Recorders (NVR) shall be distributed, and located in the TR's, as shown on the drawings or as directed by the Owner. See the drawings for details on equipment locations of this project.
3. Central Administrative Post: The video management service application is located in the Security Operations Center. System programming, configuration and control shall occur at this location or as directed by the Owner.
4. Building Administrative Post: Where applicable, Video Client workstations shall be located as shown on the drawings. Site surveillance, site camera configuration, and review of recorded images shall occur at this location.
5. Infrastructure and Connectivity
  - a. The video camera and processing components at each site shall utilize a combination of standard copper cable, fiber optic cable, IP or wireless transmission schemes, depending on individual site conditions.
  - b. Local Sites: The wired network cameras, video encoders, network video appliances, and Client Workstations shall reside on the building's local area network (LAN) or network segment. Recording, live viewing, switching, long-term storage, reviewing, and configuration shall be implemented over this infrastructure. Coordinate LAN/WAN requirements for this project with the Owner.
  - c. Enterprise: Local LAN networks are connected to the Santee Community Center LAN network, to establish VSS connectivity between Santee Community Center sites and the Security Operations Center. Coordinate LAN/WAN requirements for this project with the Owner.

D. Attributes

1. General
  - a. The Digital Video Management System (DVMS) is existing.
  - b. The system shall comprise network video appliances, video clients, digital storage devices, router/switches, and ancillary equipment assembled into a fully operating system.
  - c. Field Components: Field Components shall comprise video cameras, positioning devices, lenses, camera mounts and housings, and other video system devices and wiring as described herein and shown on the drawings.



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- d. Video Processing Components: Video processing components shall comprise computer video servers, encoders / decoders, digital storage devices, computer video monitoring stations, and other video processing devices as described herein and as needed to provide the required functionality.
  - e. Quality: The initial quality/compression parameters shall be set as determined by the Engineer and the Owner at the time of commissioning. Minimum video quality shall be equivalent to 4-CIF, or the selected camera's highest supported resolution, unless otherwise approved by the Owner.
2. Integrated Digital Video Management System
- a. The Contractor shall incorporate the following existing application software features and functionality into the new work and configure the system and devices to make use of these and any other features offered by the application software, as required by the Owner.
  - b. The VSS shall support an integrated Digital Video Management recording solution utilizing a Network Video Recorder (NVR) appliance that provides the following features and capabilities:
    - 1) Seamless integration with the VSS
    - 2) The VSS shall support Digital Network Video Recorders manufactured by the VSS manufacturer and from third party manufacturers.
    - 3) The VSS shall support analog and IP video sources.
    - 4) The Digital Video Management Software (DVMS) shall incorporate a modular architecture and be able to support an unlimited number of cameras.
    - 5) The DVMS shall be able to simultaneously record and display live video and display recorded video.
    - 6) The DVMS shall support both event based and continuous recording.
    - 7) The DVMS shall mark all events and they shall be available for playback and or archiving at any time.
    - 8) Up to 32 simultaneous users shall be able to access any video feed from any recorder on the network.
    - 9) User defined profiles for tailored granular access to configuration and operation.
    - 10) Independent camera setup for, compression rate, brightness, contrast and other factor setups.
  - c. DVMS Network Interface
    - 1) The network interface shall allow remote access of the DVMS from anywhere with established connectivity on the LAN/WAN.
    - 2) The DVMS shall have the ability to playback stored video over the LAN / WAN for remote access of video images.
  - d. The DVMS shall support the following configuration and customization parameters:
    - 1) Compression percentage
    - 2) Pre and Post event recording, in seconds
    - 3) Active Continuous Archiving
    - 4) Motion Detection Alarms
    - 5) Set Time Lapse Recording



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6) Continuous Recording Mode

3. Real Video Time Monitoring: The DVMS / IPDVMS shall allow monitoring of real time video from any Alarm Monitoring client workstation. DVMS and Camera status shall be displayed on a System Hardware Tree.
4. Matrix View: The DVMS / IPDVMS shall support an advanced Matrix View of On-line camera views. Up to 32 channels shall be able to be simultaneously displayed in the video matrix. The 32 channels shall be any combination of Live or Recorded video.
5. Pan / Tilt / Zoom Control from Alarm Monitoring: Video cameras so equipped, shall be capable of pan/tilt/zoom positioning and remote-control functions. Video camera positioning and imaging signals shall be transmitted by LAN networks as described herein, to permit remote viewing and camera control "on demand" on any LAN-connected device, from any location, with appropriate software and authorization.
6. Still Image Capture / Save: During playback or monitoring of video, the System shall have the ability to create and save a still picture.
7. Export Video Clip to File: The VSS shall have the ability to save and export recorded video to a file for the purpose of sharing and reviewing video clips. The start and end times for each video segment shall be user defined.
8. Video Loss Detection: The VSS shall detect video loss from cameras and activate an alarm.
9. Automated Motion Video Searching
10. System Redundancy: System servers and network video recorders shall be equipped with RAID 5 array hard drives to allow failed hard drives to be "rebuilt" without loss of recorded information. Hard drives shall be hot swap type.

E. Functional Requirements

1. Video Recording Protocols: Initially, configure the system as directed by the Owner, based on the following recording protocol definitions:
  - a. Recording Modes:
    - 1) Time Lapse Mode: 1 frame per every 5 seconds (fps) per camera. Cameras shall be continuously recorded at this rate.
    - 2) Event/Alarm Mode: 15 fps per camera (with pre and post 10 seconds)
  - b. Compression Codec: H.264
  - c. Compression Quality: Compression rates shall always be set at their highest quality. Automatic throttling can be used where network bandwidth is restricted, when approved by the Owner.
  - d. Resolution: Cameras should be configured to deliver streams in their highest native resolution.
  - e. Motion-Based Recording Modes: Motion detection recording modes may be implemented where directed by the Owner, but assumptions on motion cannot be used to calculate storage capacity.
2. Recording and Retrieval a. Provide a minimum hard-disk storage capacity of 30 days of recording, for cameras installed as a part of this project. Storage media shall be located in the security equipment room, communications room, security



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monitoring Center or where shown on the plans. Storage capacity shall be calculated based on the following parameters:

- a. Time Lapse Mode (1 frame per every 5 seconds (fps) per camera, high-quality compression): All cameras, 24-hours per day, 7-days per week, at highest native resolution, plus;
  - b. Assume 100% motion and complexity within the viewing area at all times for storage calculations.
3. Forensic Recording: Provide a means of recording video clips for transport such as DAT, USB, DVD or DVD-ROM, for forensic and evidentiary purposes.
4. Software routines required to accomplish the required functionality will be fully developed, installed, tested and supported by the Contractor and Manufacturer. Provide proof of manufacturer certification for any new software provided.
5. Video Storage/Retrieval
- a. Stored video will be time/date stamped and synchronized with the VSS clocks.
  - b. The system shall retrieve any stored video based on time/date parameters entered by the operator.
  - c. The system shall be capable of performing activity detection on stored video. Any recorded video channel may be selected, and a zone may be selected within the view of the camera scene. The stored video can then be searched and will only display clips of video that identify motion in the selected zone.
6. Surveillance/Display Modes
- a. Cameras may be used for assessment, to view areas of concern and provide video escort functions.
  - b. The system shall process video signals for primary display on video workstation display monitors. Video signals may be displayed in single or multi-view formats.
  - c. Selection of display formats shall be under the control of the operators, via their local video monitoring software, video control keyboards, or by computer-controlled graphical user interfaces.
  - d. Display Modes: The system shall enable one or more cameras from any combination of areas or sites to be displayed on one or more video workstations or display devices, simultaneously.
    - 1) Single Camera Display: Any individual camera may be called-up and displayed on a video workstation, and by any other properly configured computer or LAN device, with VSS monitoring software.
    - 2) Multiple Display: Up to 16 cameras may be called-up and displayed simultaneously on each video monitor with VSS monitoring software. Cameras may be called-up for multiple display without regard to their location in the system, or on the network, such that each of the 16 cameras may be from 16 different sites or areas, displayed simultaneously on a video workstation.
  - e. The system shall support independently configured display modes at each video workstation or LAN device, simultaneously. Display mode configured at one video monitoring device shall not affect the others.



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PART 2 - PRODUCTS

2.1 GENERAL

- A. Product Acceptability: The Products section contains lists of acceptable products. If product substitutions are proposed, they must be made based upon a comparison of equivalence to the product specified. Considerations may include but shall not be limited to functional, physical, aesthetic and/or interface aspects. The Owner shall be the sole judge of whether or not a submitted substitution is deemed to be "equivalent" to that specified.

2.2 2.2 VIDEO SURVEILLANCE (VSS) EQUIPMENT

A. General

1. Network Video Recorder: Provide the number of NVR recorders necessary to manage and record video cameras at the project site, as shown on the drawings and as noted herein or directed by the Owner.
2. Software
  - a. Provide Digital Watchdog software NVR component, to support the required monitoring, surveillance and recording capabilities and functionality, as specified. Ensure compatibility between the NVR application and the existing DVMS application.
  - b. Camera/Video Licenses: Provide additional number of camera licenses equal to the number of cameras shown on the drawings and added throughout the course of the project.
  - c. Client Workstations: Provide Digital Watchdog viewing software to support monitoring, surveillance, and review capabilities and functionality at the client workstations.
3. Provide VSS Client Workstations where shown on the drawings and described herein.

B. Network Video Recorder (NVR) Hardware Platform

1. The Network Video Recorder, a device for recording IP based video from IP output cameras or analog cameras that have been converted to IP output, shall consist of a PC Compatible Chassis and other specified components, as shown in the following sub sections that together create the Network Video Recorder.
2. The NVR shall be Digital Watchdog rack-mounted server class computer that meets or exceeds the current specifications for an NVR capable of processing and recording the maximum number of camera streams required for the project, as described herein. Contractor shall obtain Santee Community Center IT approval before purchase and installation.
  - a. Intel i7 processors
  - b. Storage: 200TB of storage shall be included with the CCTV hardware: Provide the number of drives necessary to provide the required storage, as specified herein.



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- c. Camera Channels: Configurable from 10 to 80 IP and 32 analog
- d. RAM configurable from 8GB to 16GB
- e. RAID 5 Controller
- f. Three-year warranty included
- g. Virus Protection: Coordinate with Santee Community Center IT.
- h. Firewall: Coordinate with Santee Community Center IT.

- 3. Digital Watchdog Network Recorder License: Provide one per camera.

C. Video Cameras

1. IP-Ready Cameras

- a. All new cameras shall be IP-ready cameras, unless the conditions of installation or other special requirements dictate that an analog type camera must be used. Any such condition must be submitted for approval, and approved by the Owner, prior to installation.
- b. Where analog cameras are approved and provided, a digital video encoder must be used to convert the analog video signal for distribution and use on the LAN/WAN Network.

2. Interior Mini-Dome Network Fixed Position Camera:

- a. Cameras shall be Digital Watchdog 5MP MegaDome.

3. Interior Elevator Mini-Dome Network Fixed Position Camera:

- a. Cameras shall be Digital Watchdog 3MP MegaDome.

4. Exterior Dome Network Fixed Position Camera:

- a. Cameras shall be Digital Watchdog 5MP MegaDome.

5. Exterior Dome Network 180/270/360 Degree Multi-sensor Camera:

- a. Cameras shall be Digital Watchdog 20MP Surround Video Omni.

6. Exterior Blue Emergency Phone Integrated Fixed Position Camera:

- a. Cameras shall be Digital Watchdog 3MP.
- b. Cameras shall be capable of being mounted within Talk-A-Phone emergency blue light tower.

D. Camera Enclosures

- 1. Provide enclosure for each camera. Submit enclosure and mounting hardware configuration to the Owner for approval prior to installation.
- 2. Ancillary hardware shall be provided by contractor if required and shall be compatible with and comparable in strength to other attached hardware.

E. Camera Enclosure Mounting Hardware

- 1. Provision for mounting hardware: Contractor shall include provision and installation of miscellaneous hardware and mounting extensions at each camera location to provide acceptable viewing performance.



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2. Ancillary Hardware shall be provided by the Contractor, if required, and shall be compatible with and comparable in strength to other attached hardware.
3. Provide wall mount, pendent mount, or ceiling mount as required by each location.
  - a. Dome cameras exposed to sunlight shall be mounted to pendant mount goose neck hardware.

F. Camera Power Supply (CPS)

1. POE Cameras: Cameras with direct IP compatibility shall be compatible with Power over Ethernet (POE) standards and will utilize POE power from the network switch. Contractor shall coordinate power provisions with the Owner. G. Wiring 1. General: Cables that are not installed in conduit shall be rated for plenum use.
2. Video:
  - a. IP Cameras, Interior or Protected Wiring: For cameras 100 meters or less from the applicable network switch, provide 23 AWG, 4-pair, plenum-rated Category 6 (CAT6) cable. See division 27 for category cable requirements.
3. Exposed Camera Wiring: Wiring between camera enclosures and their respective 'J' Box shall be in "Sealtite" flexible conduit. Sealtite shall be firmly affixed to 'J' Box cover plate and camera enclosure. Refer to camera details.
4. Other cable and cable/interface combinations must be pre-approved by both the manufacturer and the Owner, prior to installation.

G. Approved Cabling

1. Category 6 (by Division 27 Contractor)
2. Uniprise (CommScope)
3. Berk-Tek
4. Panduit
5. Mohawk
6. Belden
7. Or Approved Equal

PART 3 - EXECUTION

3.1 CAMERAS

- A. All camera housings and support brackets shall be securely attached to mounting surfaces. Use lead shields on solid masonry, wood screws on wood, and machine bolts on structural steel. All anchoring devices shall be rated to support not less than five times the total equipment weight.



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3.2 EQUIPMENT

- A. Equipment shall be installed as per the requirements specified by the manufacturer's installation guidelines and best industry practices.

3.3 CABLING

- A. All system cabling shall be installed in concealed conduit.

3.4 LABELING

- A. Label all devices with machine generated labels.
- B. Label all cables at each end of each cable. Labels shall be machine generated, wrap-around type.
- C. Labeling system shall designate the cable's origin and destination on each end of each cable.

3.5 GROUNDING PROCEDURES

- A. Provide grounding of all systems and equipment in accordance with Section 28 05 00, Security Systems General Requirements.

3.6 WIRE AND CABLE INSTALLATION PRACTICES

- A. Provide wire and cable installation in accordance with Section 28 00 00, Security Systems General Requirements.

3.7 DATABASE PREPARATION, CHECKING, AND ACTIVATION

- A. Provide database preparation, checking and activation for systems and equipment in accordance with Security Systems General Requirements, Section 28 00 00.

3.8 START-UP RESPONSIBILITY

- A. Provide start-up services for all systems and equipment in accordance with Security Systems General Requirements, Section 28 00 00.

3.9 PRELIMINARY INSPECTION AND TESTING

- A. Provide preliminary inspection and testing services for systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.



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3.10 SYSTEM PERFORMANCE TESTING AND ADJUSTING PROCEDURES

- A. Provide performance testing, burn-in, and adjusting of systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.
- B. VSS Performance Testing
  - 1. Demonstrate acceptable picture quality and camera views on each camera.
  - 2. Demonstrate acceptable picture quality on each video monitoring workstation, and display devices accessible over the Wireless LAN.
  - 3. Demonstrate no negative effects on of video image is observed while Pan-Tilt-Zoom cameras are being repositioned.
  - 4. Demonstrate switching, recording and playback functions for the video server, and digital video recorders.
  - 5. Demonstrate camera positioning functionality, on pan/tilt/zoom cameras, throughout the entire range of possible camera positions.
  - 6. Ensure primary views are acceptable. Demonstrate the view obtained by each pre-programmed camera position.
  - 7. Demonstrate automatic event-initiated recording sequences, including camera pre-positioning, where applicable.

3.11 BURN-IN PERFORMANCE PERIOD

- A. Provide a burn-in performance period to demonstrate the stability of the system, in accordance with Testing and Commissioning, Section 28 08 00.

3.12 COMMISSIONING AND VALIDATION

- A. Provide commissioning and validation services to prove and improve the effectiveness of the system, in accordance with Testing and Commissioning, Section 28 08 00.
- B. Coordinate with the Owner for the provision of these services.

3.13 FINAL PROCEDURES

- A. Perform final procedures in accordance with Section 28 00 00, Security Systems General Requirements.

3.14 TESTING AND PERFORMANCE VERIFICATION

- A. Included under this section is the aiming and testing of the complete CCTV system and the interface to the components of the security system.
- B. Prior to final installation of CCTV cameras, the Contractor shall verify the specified lens size is correct for the final building design/construction. Confirm the proper field of



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view for each location. Install cameras at the approximate locations shown on the Drawings. Field adjustments shall be made as required to provide or improve the field of view of the area to be monitored.

- C. Align and adjust all video cameras and synchronize all switchers, pan, tilt and zooms to provide smooth, glitch-free operation and to optimize the images at the display monitor.
- D. If the need for additional adjustment becomes evident during demonstration and testing, the Contractor's work shall be continued until the installation operates properly. If final acceptance is delayed because of defective equipment or because installation is not in accordance with these Specifications, the Contractor shall pay for all additional time and expense during any extensions of the acceptance-testing period.
- E. Contractor shall program, label and set up systems to the satisfaction of the Owner. The Owner shall direct the Contractor as to the system programming and labeling requirements. A factory-trained technician shall fully test and operate the system. Upon completion, a manufacturer's letter shall confirm testing and programming has been completed and that the system operates all component features and to its designed maximum potential.
- F. Camera recording and display configurations shall be arranged via a combination of the Video Server, Network Video Recorders, Video Monitoring Workstations, and LAN/Wireless LAN network.
- G. Contractor shall coordinate with the Owner to determine the required pre-programmed surveillance and event-initiated configurations.

3.15 WARRANTY AND SERVICE RESPONSIBILITY

- A. All equipment, components, etc., shall be guaranteed free of defects and any faulty workmanship for a period of one year after final acceptance.
- B. The Contractor shall replace defective materials and repair faulty workmanship within 24 hours of discovery, except emergency conditions (system failures), which must be placed in service within six (6) hours after notification, all at no cost to the Owner.

3.16 EXISTING SYSTEMS AND SUBSYSTEMS

- A. Video Surveillance System (VSS)
  - 1. Digital Watchdog Enterprise
    - a. The primary system for recording and monitoring campus cameras is the digital video surveillance system manufactured by Digital Watchdog. The system provides visual monitoring of strategic areas of Santee Community Center grounds and/or facilities, and is entirely LAN network-based, using TCP/IP encoders, digital video recorders, digital recording media, network video recorders and "virtual" switching / viewing software.



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- b. Command and Control: The system is monitored and managed from the Security Operations Center, via VSS workstations and the appropriate viewing software. Connectivity is made via Local Area Network (LAN).
- 2. Modifications to the Existing System
  - a. The Contractor shall use and expand, as necessary, the existing system as part of this work, including but not limited to servers, encoders, recorders, input/output modules, control keyboards, workstations, software, software licensing, wiring, cameras, and appurtenances.
  - b. Contractor shall subcontract with the Owner's service and maintenance providers to ensure new additions and modified systems are fully and seamlessly integrated into the existing system.
- B. Contractor and Manufacturer shall guarantee in writing equipment and software which is added as part of this work is fully compatible with the existing system, is fully supported by the existing system manufacturer(s), and is configured as described in the specifications. New equipment shall be fully warranted by the Contractor as specified herein.
- C. Contractor shall ensure hardware and software is fully integrated into the existing system to present a single, seamless operating system. Contractor shall fully develop and support all hardware and software integration schemes.
- D. Control components which require unique, or proprietary, hardware or software interfaces to achieve parity with the existing system architecture are not acceptable.
- E. If records exist, drawings and diagrams of the existing systems will be made available, through the Owner, to the Contractor. The Contractor shall survey, research and confirm the existing equipment and configuration in-place, and coordinate expansion of the systems with the Owner to avoid any interruption in services.
- F. Contractor shall guarantee the existing equipment and software shall be protected from corruption or damage during the installation, programming and commissioning process

**END OF SECTION 28 23 00**



## **SECTION 28 31 00 - DIGITAL ADDRESSABLE FIRE-ALARM SYSTEM**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and the following, apply to the work of this Section:
  - 1. Section 26 05 00, COMMON WORK RESULTS FOR ELECTRICAL.
  - 2. Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS.
  - 3. Section 26 05 53, IDENTIFICATION FOR ELECTRICAL SYSTEMS.
  - 4. Section 26 05 29, HANGERS AND SUPPORT FOR ELECTRICAL SYSTEMS.

#### **1.2 SUMMARY**

- A. This performance specification provides the minimum requirements for the Life Safety System. The work provided shall include, but not limited to furnishing all permits, equipment, materials, delivery, labor, documentation, testing and services necessary to design and furnish and install a complete, operational system Fire Alarm System.

#### **1.3 REFERENCES**

- A. All work and materials shall conform to all applicable Federal, State and local codes and regulations governing the installation.
- B. Fire alarm system, equipment, installation, and wiring materials and methods used shall comply with the following codes and standards:
  - 1. System components proposed in this specification shall be UL listed for its intended use.
    - a. UL 864 (9<sup>th</sup> Edition) Control Units for Fire-Protective Signaling Systems (UOJZ), and Smoke Control Service (UUKL)
    - b. UL 2572 Control and Communication Units for Mass Notification Systems
    - c. UL 268 Smoke Detector for Fire Protective Signaling Systems
    - d. UL 268A Smoke Detectors for Duct Applications
    - e. UL 521 Heat Detectors for Fire Protective Signaling Systems
    - f. UL 464 Audible Signaling Appliances
    - g. UL 1971 Signaling Devices for the Hearing Impaired
    - h. UL 38 Manually Actuated Signaling Boxes
    - i. UL 1480 Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
    - j. UL 1481 Power Supplies for Fire Protective Signaling Systems



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- k. UL-1638 Signaling Appliances – Private Mode Emergency and General Utility Signaling
- 2. California State Listings as follows.
  - a. California State Fire Marshall (CSFM) Listed
  - b. OSHPD Special Seismic Certification Preapproval (OSP)
- 3. California Adopted Codes referenced as follows.
  - a. 2016 California Building Code
  - b. 2016 California Fire Code
  - c. 2016 California Mechanical Code
  - d. 2016 California Electrical Code
  - e. NFPA 72 - 2016 National Fire Alarm Code®, As amended by CA code
  - f. NFPA 92 - 2015 Standard for Smoke Control Systems
  - g. Americans with Disabilities Act (ADA)
- 4. Current County or City Amendments to 2016 California Codes

#### 1.4 SYSTEM DESCRIPTION

- A. The System supplied under this specification shall utilize node-to-node, direct wired, multi priority peer-to-peer network operations. The system shall utilize independently addressed, input/output modules, audio amplifiers, and voice communications if applicable and as described in this specification. The peer-to-peer network shall contain multiple nodes consisting of the command center, main controller, remote control panels, and LCD panels. Each panel shall be an equal, active functional member of the network, which can make all local decisions and generating network tasks to other panels in the event of panel failure or communications failure between panels. Master/slave system configurations shall not be considered as equals.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. The scope of work shall consist of the following minimum requirements.
  - 1. Control Panels and Annunciators
    - a. New Fire Alarm Control Panel (FACP) shall be provided in the building(s) electrical closet or in fire control room if provided. Additional related remote FACP panels shall be provided as needed.
    - b. Update the existing LCD annunciator shall be provided at PBX and at the main lobby. The annunciator shall report activity and control all fire alarm functions in the buildings.
    - c. LCD annunciators shall be provided at each nurse station to report all fire alarm related activity within the patient's rooms under their supervision. Control capabilities shall be removed at these locations.
    - d. All control panels and annunciators shall complete the "network" between all areas of the building allowing for one common dialer to be installed for central station monitoring. A new dialer shall be installed in the fire alarm



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panel in the fire control room or primary FACP location identified by the AHJ. New telephone lines if required shall be run from the telephone closet over to the newly installed dialer.

2. Initiating Devices

- a. All initiating devices shall be new addressable devices as specified. Any conventional initiating devices utilized shall have individual addressable monitor modules provided for each conventional device for unique addressing and annunciation.
- b. Smoke detectors shall be added as follows.
  - 1) All public and private areas and all rooms for 100% full area coverage.
  - 2) Additional smoke detectors may be required to ensure proper detection at the following locations.
    - a) Elevator machine room, machinery space, control room, control space and lobby for elevator recall.
    - b) Magnetically held open or automatic-closing doors.
    - c) Roll doors and/or one-hour fire-resistive occupancy separations.
    - d) Elevator Shafts if required per code.
    - e) Above each fire alarm control panel or booster power supply.
    - f) Smoke or Smoke/Fire Dampers (in lieu of duct smoke detector at damper)
    - g) Beam pockets shall be covered as needed in order to meet current code requirements.
- c. Manual pull stations shall be added as follows.
  - 1) At all exits from the building.
  - 2) At every exit from every level
- d. Duct Detectors shall be added as follows.
  - 1) Downstream of the air filters and ahead of any branch connections in air supply systems having a capacity greater than 2000 cfm.
  - 2) At each story prior to the connection to a common return and prior to any recirculation or fresh air inlet connection in air return systems having a capacity greater than 15,000 cfm and serving more than one story.
  - 3) Return system smoke detectors shall not be required where the entire space served by the air distribution system is protected by a system of area smoke detectors.
  - 4) Smoke detectors shall not be required for fan units whose sole function is to remove air from the inside of the building to the outside of the building.
  - 5) Smoke and combination Smoke/Fire Dampers.
    - a) Duct smoke detectors not required for dampers where the entire space served by the smoke damper is protected by a system of area smoke detectors.



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- 6) Remote LED's w/ test stations shall be provided for all duct detectors located above ceilings or out of sight.
  - 7) In the main return air and exhaust air plenum of each air-conditioning system having a capacity greater than 2,000 cfm. Such detectors shall be located in a service the area downstream of the last duct inlet.
  - 8) At each connection to a vertical duct or riser serving two or more stories from a return air duct or plenum of an air-conditioning system.
  - 9) A smoke detector is allowed to be used in each return air riser carrying not more than 5,000 cfm and serving not more than 10 air-inlet openings.
- e. Heat Detectors shall be added as follows.
- 1) Elevator Machine Rooms
  - 2) Elevator Shafts if required per code.
  - 3) Non-Residential Kitchens with smoke producing equipment.
  - 4) Trash Rooms
  - 5) In lieu of smoke detection in Science labs, Auto shops, welding/metal and wood working shops and other areas where experiments or other activity produce inordinate amounts of fumes or other particulates that will initiate "nuisance" alarms.
  - 6) In lieu of smoke detection near shower rooms or other areas that produce steam.
- f. Sprinkler tamper and waterflow switches shall be individually monitored.
- 1) Provide one (1) supervisory module circuit for each sprinkler valve supervisory and waterflow switch.
  - 2) Tamper switches in fire pump room only may be grouped together as allowed per coded.
3. Notifications Devices
- a. Chimes shall be added as follows.
- 1) Shall be added throughout public and private spaces to achieve 10db above ambient as needed to alert staff and meet current code requirements.
- b. Fire Alarm Strobes shall be added in public use areas and common use areas including but not limited to:
- 1) Restrooms and Similar Uses: Public, Staff, Patient (serving other than individual patient rooms), locker rooms and dressing rooms.
  - 2) Corridor System and Similar Uses: Public, Staff and Service Corridors, Vestibules and Passageways.
  - 3) Gymnasiums and Similar Uses: Physical, Rehabilitation and Occupational Therapy rooms
  - 4) Multipurpose Rooms and Similar Uses: Auditoriums, Dining Rooms, Cafeterias, Outdoor Patios & Courts that require exiting through the building and are an occupied portion of the building.



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- 5) Occupied Rooms where Ambient Noise Impairs Hearing of the Fire Alarm and Similar Uses: Kitchens, Laundry areas, Central Sterilization, Mechanical equipment rooms, Generator rooms, Boiler Rooms and Power Plants.
  - 6) Lobbies and Similar Uses
  - 7) Meeting Rooms and Similar Uses: Conference rooms, Waiting rooms, Reception rooms/areas, Lounges and Chapels.
  - 8) Any Other area for common use with an occupant load of at least seven (7) and similar uses: Pharmacies, Laboratories, Office rooms/areas.
  - 9) Rooms used for sleeping and Similar Uses, (Not to include Patient Rooms): Sleeping rooms and suites for persons with hearing impairments. Application of this requirement shall be by sleeping room/suite type (e.g. doctors sleeping, family sleeping, etc.)
    - a) Strobes that are required in sleeping areas shall be located within 16' of pillow and have a minimum intensity of 110cd. For strobes located less than 24" from ceiling the minimum intensity shall be 117cd.
  - 10) Any other area for common use.
  - 11) Additional strobes shall be added in ADA rooms as needed.
  - 12) Sized Per ADA coverage and NFPA72
  - 13) Combination Audible/Visual appliances may be used as needed.
  - 14) Areas having more than 2 strobes in the field of view shall be synchronized
  - 15) Attached parking garage shall have coverage throughout.
- c. Patient Room Dome Lamps
- 1) Corridor side of each patient sleeping room.
  - 2) Non Supervised connection directly off patient room smoke detector, interfaced with fire alarm system via modules or integrated with patient nurse call system as allowable by code.
4. Booster Power Supplies shall be distributed throughout the facility to provide the power necessary for all indicating devices. Power Supplies shall be initiated by Synchronized Signal Modules. Synchronization by means of a common pair of wires chaining power supplies shall not an acceptable means of synchronization between units.
5. Fan and Damper control as follows.
- a. Interface and provide air-handling systems shutdown control. An addressable control relay shall be provided for each air handler unit.
  - b. Interface and provide non-managed smoke damper shutdown. Provide addressable control relays at each electrical panel where smoke dampers are powered.
6. Elevator Interface Cabinet
- a. Provide red metal cabinet enclosure with word FIRE in white letters on the cover. Inside will be four intelligent relays (Primary Recall, Alternate



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Recall, Fire Hat and Shunt Trip), one monitor input (Shunt Trip AC Power Supervision) and 120vac relay (Shunt Trip AC Power Supv).

7. Other device/controls shall be added as follows.
  - a. The fire alarm panel shall monitor individual Fire Pump and Emergency Generator "Run" & "Fail" status for each unit. Run & Fail Status shall report as Monitor points.
  - b. The fire alarm panel shall monitor individual kitchen hood panel "Alarm" & "Trouble" status for each unit.
  - c. Interface with any door lock\card accesses release circuits. An addressable control relay shall be provided at each lock location obstructing the emergency exit path. Stairwell door locks may have one common control.
  - d. Provide and Interface with magnetic door holder release circuits including WON doors. Provide addressable control relays as required.
  - e. Magnetic door holders shall be provided as part of this section at elevator lobby doors and all cross-corridor doors and as required per code.

## 1.6 SEQUENCE OF OPERATIONS

- A. General Alarm Operation: Upon alarm activation of any area smoke detector, duct smoke detector, heat detector, manual pull station, sprinkler waterflow, the following functions shall automatically occur:
  1. The internal audible device shall sound at the control panel, annunciator or command center.
  2. The LCD Display shall indicate all applicable information associated with the alarm condition including zone, device type, device location and time/date.
  3. All system activity/events shall be documented on the system printer.
  4. Any remote or local annunciator LCD/LED's associated with the alarm zone shall be illuminated.
  5. The following notification signals and actions shall occur simultaneously:
    - a. A signal shall be sounded on all fire floors (zones). The signal shall be a Chime tone.
    - b. Activate visual strobes on all fire floors (zones). The visual strobe shall stop operating when the "Alarm Silence" is pressed.
  6. Transmit signal to the building automation system (if applicable) and/or shutdown all HVAC units serving the floor of alarm.
  7. Transmit signal to the 24/7 PBX room with point identification.
  8. Activate automatic smoke control sequences (if applicable).
  9. All stairwell/exit doors shall unlock throughout the building.
  10. All self-closing fire/smoke doors held open shall be released.
  11. All automatic events programmed to the alarm point shall be executed and the associated outputs activated.



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- B. Elevator Lobby / Equipment Room Detectors: Upon alarm activation of any elevator lobby smoke detector or equipment room detector the following functions shall automatically occur:
1. Perform general alarm sequence above.
  2. Elevator Lobby smoke detectors shall recall the elevators to primary floor
  3. Elevator Lobby smoke detectors located on the primary recall floor shall recall the elevator the alternate floor.
  4. Equipment room smoke detectors shall recall the elevator to the primary floor.
  5. Activation of the Equipment room heat detector shall initiate the shunt trip in the associated elevator equipment room.
- C. Patient Room Detectors: Upon alarm activation of any patient room smoke detector the following functions shall automatically occur:
1. Perform general alarm sequence above.
  2. Individually activate the room dome light for each patient room in alarm.
  3. Activate an audible & visible signal at the Nurse station associated with the patient room.
  4. The room number and type of event shall be displayed at the remote LCD Annunciator located at the Nurse station for that patient room.
- D. Supervisory Operation: Upon supervisory activation of any sprinkler valve supervisory switch, fire pump off-normal, clean agent fire suppression system trouble, the following functions shall automatically occur:
1. The internal audible device shall sound at the control panel, annunciator or command center.
  2. The LCD display shall indicate all applicable information associated with the supervisory condition including; zone, device type, device location and time/date.
  3. All system activity/events shall be documented on the system printer.
  4. Any remote or local annunciator LCD/LED's associated with the supervisory zone shall be illuminated.
  5. Transmit signal to the central station with point identification.
- E. Trouble Operation: Upon activation of a trouble condition or signal from any device on the system, the following functions shall automatically occur:
1. The internal audible device shall sound at the control panel, annunciator or command center.
  2. The LCD keypad display shall indicate all applicable information associated with the trouble condition including; zone, device type, device location and time/date.
  3. All system activity/events shall be documented on the system printer.
  4. Any remote or local annunciator LCD/LED's associated with the trouble zone shall be illuminated.
  5. Transmit signal to the central station with point identification.
- F. Monitor Activation: Upon activation of any device connected to a monitor circuit (fire pump/emergency generator status), the following functions shall automatically occur:



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1. The LCD display shall indicate all applicable information associated with the status condition including; zone, device type, device location and time/date.
2. All system activity/events shall be documented on the system printer.
3. Any remote or local annunciator LCD/LED's associated with the status zone shall be illuminated.

1.7 SYSTEM DESIGN PARAMETERS

A. Standby power

1. The standby power supply shall be an electrical battery with capacity to operate the system under maximum supervisory load for twenty four (24) hours and capable of operating the system for five (5) minutes of evacuation alarm on all devices, operating at maximum load. The system shall include a charging circuit to automatically maintain the electrical charge of the battery. The system shall automatically adjust the charging of the battery to compensate for temperature.

B. Voltage Drop

1. Under all operating conditions, the voltage on the NAC must be sufficient to operate all the notification appliances so that they deliver the proper signal intensity.

C. Spare Capacity

1. The system shall be engineered to accommodate 20% spare capacity on each individual loop, and 20% spare on system power supplies.

D. Circuiting Guidelines

1. Initiating Device Circuits
  - a. Where necessary, conventional initiating device circuits (i.e. waterflow switches, valve supervisory switches, fire pump functions, etc.) shall be Class B (Style "A" or "B").
2. Notification Appliance Circuits
  - a. All notification appliance circuits shall be Class B (Style "Y"). The notification circuits shall be power limited. Non-power limited circuits are not acceptable.
3. Signaling Line Circuits: Addressable Analog Devices
  - a. The signaling line circuit connecting to addressable/analog devices including, detectors, monitor modules, control modules, isolation modules, intrusion detection modules and notification circuit modules shall be Class B (style 4).
  - b. Each addressable analog loop shall be circuited so device loading is not to exceed 80% of loop capacity in order to leave for space for future devices.



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- c. A single fault on a pathway connected to the addressable devices shall not cause the loss of more than 50 addressable devices.
- 4. Signaling Line Circuits: Data & Audio for FACP & Annunciator Network
  - a. The signaling line circuit connecting network panel/nodes, annunciators, command centers, shall be Class A (style 7). The media shall be copper except where fiber optic cable is specified on the drawings.

1.8 SUBMITTALS – FOR REVIEW/APPROVAL

A. General

- 1. It is the responsibility of the contractor to meet the entire intent and functional performance detailed in these specifications.
- 2. The proposed equipment shall be subject to the approval of the Architect/Engineer/Owner.
- 3. Approved submittals shall only allow the contractor to proceed with the installation and shall not be construed to mean that the contractor has satisfied the requirements of these specifications.

B. Product Data

- 1. Provide list of all types of equipment and components provided. This shall be incorporated as part of a Table of Contents, which will also indicate the manufacturer's part number, the description of the part, and the part number of the manufacturer's product datasheet on which the information can be found.
- 2. Provide manufacturer's data sheets with the printed logo or trademark of the manufacturer for all equipment. Indicated in the documentation will be the type, size, rating, style, and catalog number for all items proposed to meet the system performance detailed in this specification.
- 3. CSFM listing sheet for each component
- 4. OSHPD Special Seismic Certification Preapproval (OSP)

C. Shop Drawings

- 1. A complete set of shop drawings shall be supplied. The shop drawings shall be reproduced electronically in digital format. This package shall include but not be limited to:
  - a. All drawings and diagrams shall include the contractor's title block, complete with drawing title, contractor's name, address, date including revisions, and preparer's and reviewer's initials
  - b. Complete system bill of material with peripheral device back box size information, part numbers, device mounting height information
  - c. Detailed system operational description. Any Specification differences and deviations shall be clearly noted and marked.
  - d. A riser diagram that individually depicts all control panels, annunciators, addressable devices and notification appliances. Field addressable



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devices and notification appliances may be grouped together by specific type per loop or circuit if allowed by AHJ.

- e. Complete 1/8" = 1'-0 scale floor plan drawing locating all system devices and elevation of all equipment at the Fire Command Station. Floor plans shall indicate accurate locations for all control and peripheral devices as well as raceway size and routing, junction boxes, and conductor size, and quantity in each raceway. All notification appliances shall be provided with a candela rating and circuit address that corresponds to that depicted on the Riser Diagram. If individual floors need to be segmented to accommodate the 1/8" scale requirements, KEY PLANS and BREAK-LINES shall be provided on the plans in an orderly and professional manner. End-of-line resistors (and values) shall be depicted.
- f. All drawings shall be reviewed and signed off by an individual having a minimum of a NICET 3 certification in fire protection engineering technology, subfield of fire alarm systems.
- g. Control panel wiring and interconnection schematics. The drawing(s) shall depict internal component placement and all internal and field termination points. Drawing shall provide a detail indicating where conduit penetrations shall be made, so as to avoid conflicts with internally mounted batteries. For each additional data-gathering panel, a separate control panel drawing shall be provided, which clearly indicated the designation, service and location of the control enclosure.
- h. Complete voltage drop calculations that clearly indicate the quantity of devices, the device part numbers, the supervisory current draw, the alarm current draw, voltage drop and totals for all categories.
- i. System (Load & Battery) calculations shall be provided for each system power supply and control panel, providing power for a notification appliance circuit, auxiliary control circuit or any circuit that draws power from any system power supply. Battery calculations shall also reflect all control panel component, remote annunciator, and auxiliary relay current draws.
- j. All seismically qualified equipment must be submitted with design drawings and required calculations that indicate the mounting methods implemented to achieve the compliance with these requirements including the following.
  - 1) Dimensioned Outline Drawings of Equipment Units: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 2) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  - 3) Dimension specifications for additional equipment required to meet these requirements.
- k. Any additional requirements if required by AHJ for approval.

D. General Submittal Requirements

- 1. Installer's NICET 3 Certification
- 2. Letter or Certificate from the fire alarm manufacturer stating that the fire alarm contractor is an authorized distributor of the specified product.
- 3. Submit a copy of the system supplier's training certification for the specified product issued by the manufacturer of the integrated life safety system.



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4. Equipment submittals and other documentation shall be incorporated bound with the information indexed and tabbed for quick reference.

#### 1.9 CLOSEOUT SUBMITTALS

- A. Minimum two (2) copies of the closeout documents shall be delivered to the building owner's representative at the time of system acceptance.
- B. Provide the name, address and telephone of the authorized factory representative.
- C. As-Built Drawings
  1. Drawings consisting of: a scaled plan of each building showing the placement of each individual item of the Integrated Life Safety System equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway.
  2. All drawings must reflect point to point wiring, device address and programmed characteristics as verified in the presence of the engineer and/or the end user unless device addressing is electronically generated, and automatically graphically self-documented by the system.
  3. All drawings shall be provided in standard .DXF or AutoCAD format.
- D. Operation & Maintenance Data:
  1. Manufacturer's data sheets for all equipment supplied.
  2. Manufacturer's Operation & Maintenance Manual
  3. A filled-out Record of Completion as defined or similar to those provided in NFPA 72.
  4. Abbreviated operating instructions for mounting at fire alarm control panel.
- E. Software
  1. Electronic record copy of site-specific software on non-volatile, non-erasable, non-rewritable media shall be provided to owner. A copy shall be stored and secured on site.
  2. Printed Device list w/ Labels and Device/Serial Numbers

#### 1.10 QUALITY ASSURANCE

- A. All work specified in this Section shall be performed (furnished, installed and connected) by a qualified fire alarm contractor.
  1. Submit evidence of completion and satisfactory operation of five projects of equal scope for the specified system. Identify projects and include names of operating personnel familiar with the system operation.
  2. Submit evidence that installers are factory authorized agents.
  3. Submit letter from equipment manufacturer indicating intent to maintain local service organizations or direct factory service. Indicate the travel distance to the project site.



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PART 2 - - PRODUCTS

2.1 MANUFACTURERS

- A. All panels and peripheral devices shall be of the standard product of single. The catalog numbers specified under this section are those of Edwards, a UTC Climate, Control & Security Company and shall constitute the type, product quality, material and desired operating features.

2.2 GENERAL

- A. All equipment and components shall be the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approval agency for use as part of a protected premises (fire alarm) system.
- B. The contractor shall provide, from the acceptable manufacturer's current product lines, equipment and components, which comply, with the requirements of these specifications. Equipment or components, which do not provide the performance and features, required by these specifications are not acceptable, regardless of manufacturer.
- C. All System components shall be the cataloged products of a single supplier. All products shall be UL listed by the manufacturer for their intended purpose.
- D. All control panel assemblies and connected field appliances shall be both designed and manufactured by the same company, and shall be tested and cross-listed as to ensure that a fully functioning system is designed and installed.

2.3 FIRE ALARM CONTROL PANEL (FACP)

- A. General, EST3, CSFM 7165-1657:0186
  - 1. The fire alarm control panel or panels and all system devices (Audible-Visuals, Visuals, pull stations, smoke and heat detectors, etc. shall be all under one label "UL/UOJZ listed and approved" for the use of fire alarm systems in the project area.
  - 2. The operating controls shall be located behind locked door with viewing window. All control modules shall be labeled, and all zone locations shall be identified.
  - 3. The main controller 3-CPU shall be supervised, site programmable, and of modular design supporting up to 64 network nodes. The peer-to-peer network shall contain multiple nodes consisting of the command center, main controller, remote control panels, LCD/LED annunciation nodes, and workstations. Each node is an equal, active functional node of the network, which is capable of making all local decisions and generating network tasks to other nodes in the event of node failure or communications failure between nodes. When utilizing a



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network and multiple wiring faults occur, the network shall re-configure into many sub-networks and continue to respond to alarm events from every panel that can transmit and receive network messages.

4. The Main Controller Module shall control and monitor all local or remote peripherals. It shall support a large 168-character LCD, power supply, remote LCD and zone display annunciators, printers, and support communication interface standard protocol (CSI) devices such as color computer annunciators and color graphic displays.
5. Each controller shall contain a RS232 printer/programming port for programming locally via an IBM PC. When operational, each controller shall support a printer through the RS232 port and be capable of message routing.
6. The programmer shall be able to download all network and firmware applications from the configuration computer to all the network panels from a single location on the system.
7. The panels shall have the ability to add an operator interface control/display at each node that shall annunciate, command and control system functions.
8. The system shall store all basic system functionality and job specific data in non-volatile memory. All site specific and operating data shall survive a complete power failure intact. Passwords shall protect any changes to system operations.
9. The control panel shall contain a standby power supply that automatically supplies electrical energy to the system upon primary power supply failure. The system shall include a charging circuit to automatically maintain the electrical charge of the battery.

B. Signaling Line Circuits

1. The main controller 3-CPU shall be supervised, site programmable, and of modular design supporting up to 125 detectors and 125 remote modules per addressable Signaling Line Circuit (SLC). The CPU shall support up to 10 SLC's per panel for a total system capacity of 2500 Intelligent Addressable points. The system shall be designed with peer-to-peer networking capability for enhanced survivability, with support for up to 64 nodes, each with up to 2500 points and an overall capacity of 160,000 points.
2. The system shall provide electronic addressing of analog/addressable devices.
3. The system shall have built-in automatic system programming to automatically address and map all system devices attached to the main controller.
4. The system shall use full digital communications to supervise all addressable loop devices for placement, correct location, and operation. It shall allow swapping of "same type" devices without the need of addressing and impose the "location" parameters on replacement device. It shall initiate and maintain a trouble if a device is added to a loop and clear the trouble when the new device is mapped and defined into the system.
5. The system shall have a UL Listed Detector Sensitivity test feature, which will be a function of the smoke detectors and performed automatically every 4 hours.

C. DACT



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1. The system shall provide off premise communications capability (DACT) for transmitting system events to multiple Central Monitoring Station (CMS) receivers.
2. The system shall be capable of providing the CMS(s) with point identification of system events using Contact ID or SIA DCS protocols.
3. In the event of a panel CPU failure during a fire alarm condition, the DACT degrade mode shall transmit a general fire alarm signal to the CMS.

D. User Interface

1. Main Control & Display
  - a. The main display shall be a large 168 character LCD with normal, alarm, trouble, supervisory, disabled point and ground fault indicators.
  - b. The interface shall show the first and most recent highest priority system events without any operator intervention. All system events shall be directed to one of four message queues. Messages of different types shall never be intermixed to eliminate operator confusion. A "Details" switch shall provide additional information about any device highlighted by the operator.
  - c. Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel(s) and at each remote annunciation device. The integral audible devices shall produce a sound output upon activation of not less than 85 dBA at 10 feet.
  - d. The internal audible signal shall have different programmable patterns to distinguish between alarm, supervisory, trouble and monitor conditions.
  - e. The annunciator shall contain the following controls:
    - 1) System Reset Switch with Indicator
    - 2) System Alarm Silence Switch with Indicator
    - 3) System Panel Silence Switch with Indicator
    - 4) Programmable Switch with Indicator
    - 5) Details Switch
    - 6) System Message Queue Scroll Switches.
    - 7) 10-Digit Keypad to Enable/Disable System and Functions.
  - f. An authorized operator shall have the ability to operate or modify system functions like system time, date, passwords, holiday dates, restart the system and clear control panel event history file.
  - g. An authorized operator shall be capable of performing test functions within the installed system.
2. Additional Annunciation & Control
  - a. The system shall be capable to receive, monitor, and annunciate signals from each individual device and circuit installed throughout the fire alarm network.

E. Internal Modular Power Supply

1. System power supply(s) shall provide multiple power limited 24 VDC output circuits as required by the panel.



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2. Upon failure of normal (AC) power, the affected portion(s) of the system shall automatically switch over to secondary power without losing any system functions.
3. Each system power supply shall be individually supervised. Power supply trouble signals shall identify the specific supply and the nature of the trouble condition.
4. All standby batteries shall be continuously monitored by the power supply. Low battery and disconnection of battery power supply conditions shall immediately annunciate as battery trouble and identify the specific power supply affected.
5. All system power supplies shall be capable of recharging up to 260AH batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.

F. Reports

1. The system shall provide the operator with system reports that give detailed description of the status of system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the main LCD, and shall be capable of being printed on any system printer.
2. The system shall provide a report that gives a sensitivity listing of all detectors that have less than 75% environmental compensation remaining. The system shall provide a report that provides a sensitivity (% Obscuration per foot) listing of any particular detector.
3. The system shall provide a report that gives a listing of the sensitivity of all of the detectors on any given panel in the system, or any given analog/addressable device loop within any given panel.
4. The system shall provide a report to determine the carbon monoxide detectors end-of-life.
5. The system shall provide a report that gives a chronological listing of up to the last 1740 system events.
6. The system shall provide a listing of all of the firmware revision listings for all of the installed network components in the system.

G. System Printer

1. The event and status printer shall be a 9-pin, impact, dot matrix printer.
2. The printer shall be capable of serial or parallel communications protocol.
3. The communications speed for RS-232 communications protocol shall be adjustable from 300 to 9600 Baud.
4. The printer shall list the time, date, type and user defined message for each event printed.

2.4 ANNUNCIATORS

A. General

1. The system shall have the capacity to support 64 network annunciators or EST3 network panel nodes.

B. Remote LCD Annunciator, 3ANN, CSFM 7120-1657:193



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1. Remote LCD annunciators shall display each and every point in the system and be sized with the same number of characters as in the main FACP display. Annunciators not capable of displaying each point will not be considered equal. Grouping points to "zones" will not be acceptable.
2. Network alphanumeric annunciators shall be located throughout the facility as indicated on the plans and in the fire safety director's office. This annunciator shall be an Integral part of the Peer to Peer Network for survivability. Systems that require a "host" Network Node to control remote annunciators shall not be considered acceptable.
3. Each annunciator shall contain a supervised, back lit, liquid crystal with a minimum of 8 line with 21 characters per line. Where required, the annunciator shall include additional zonal annunciation and manual control without additional enclosures. The annunciator shall support full ability to serve as the operating interface to the system and shall include the following features;
  - a. Matched appearance with other system displays
  - b. Each LCD Display on each node (cabinet) in the system shall be configurable to show the status of any or all of the following functions anywhere in the system:
    - 1) Alarm
    - 2) Supervisory
    - 3) Trouble
    - 4) Monitor
4. Each annunciator must be capable of supporting custom messages as well as system event annunciation. It must be possible to filter unwanted annunciation of trouble, alarm or supervisory functions on a by point or by geographic area. The annunciators shall be mounted in stand-alone enclosures or integrated into the network panels as indicated on the plans.

## 2.5 INTELLIGENT ADDRESSABLE DETECTORS

### A. General

1. Each remote device shall have a microprocessor with non-volatile memory to support its functionality and serviceability. Each device shall store as required for its functionality the following data: device serial number, device address, device type, personality code, date of manufacture, hours in use, time and date of last alarm, amount of environmental compensation left/used, last maintenance date, job/project number, current detector sensitivity values, diagnostic information (trouble codes) and algorithms required to process sensor data and perform communications with the loop controller.
2. Each device shall be capable of electronic addressing, either automatically or application programmed assigned, to support physical/electrical mapping and supervision by location. Setting a device's address by physical means shall not be necessary.
3. The System Intelligent Detectors shall be capable of full digital communications using both broadcast and polling protocol. Each detector shall be capable of



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performing independent fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns and combine different fire parameters to increase reliability and distinguish real fire conditions from unwanted deceptive nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by digital filters. Devices not capable of combining different fire parameters or employing digital filters shall not be acceptable.

4. Each detector shall have an integral microprocessor capable of making alarm decisions based on fire parameter information stored in the detector head. Distributed intelligence shall improve response time by decreasing the data flow between detector and analog loop controller. Detectors not capable of making independent alarm decisions shall not be acceptable. Maximum total analog loop response time for detectors changing state shall be 0.75 seconds. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. Systems using central intelligence for alarm decisions shall not be acceptable.
5. The detector shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, aging and humidity. The information shall be stored in the integral processor and transferred to the analog loop controller for retrieval using a laptop PC or the SIGA-PRO Signature Program/Service Tool.
6. Each detector shall have a separate means of displaying communication and alarm status. A bicolor green/red LED shall flash to confirm communication with the analog loop controller and display alarm status.
7. The detector shall be capable of identifying up to 32 diagnostic codes. This information shall be available for system maintenance. The diagnostic code shall be stored at the detector.
8. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings.
9. Each detector microprocessor shall contain an environmental compensation algorithm, which identifies and sets ambient "Environmental Thresholds" approximately six times an hour. The microprocessor shall continually monitor the environmental impact of temperature, humidity, other contaminants as well as detector aging. The process shall employ digital compensation to adapt the detector to both 24-hour long-term and 4 hour short-term environmental changes. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the "learned" base line sensitivity. The base line sensitivity information shall be updated and permanently stored at the detector approximately once every hour.
10. The intelligent analog detectors shall be suitable for mounting on any Signature Series detector mounting base.
11. The Fire alarm system shall have the ability to set individual smoke detectors for alarm verification. Detector in the alarm verification mode shall indicate, by point in a text format at the main control and at the remote LCD annunciators.



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B. Photoelectric Smoke Detector, SIGA-PD, CSFM 7272-1657:0331

1. Provide intelligent photoelectric smoke detectors SIGA-PD. The analog photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings.
2. Each unit shall have the capability of adding optional field-replaceable carbon monoxide sensor/daughterboard module
3. The photo detector shall be rated for ceiling installation at a minimum of 30-ft centers and be suitable for wall mount applications.
4. The photoelectric smoke detector shall be suitable for direct insertion into air ducts up to 3-ft high and 3-ft wide with air velocities up to 4,000 ft/min without requiring specific duct detector housings or supply tubes.
5. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The photo detector shall be suitable for operation in the following environment:
  - a. Temperature: 32°F to 120°F
  - b. Humidity: 0-93% RH, non-condensing

C. Fixed Temp/Rate of Rise Heat Detector, SIGA-HRD, CSFM 7270-1657:0333

1. Provide intelligent combination fixed temperature/rate-of-rise heat detectors SIGA-HRD. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature and at a temperature rate-of-rise. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm.
2. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable.
3. The intelligent heat detector shall have a nominal fixed temperature alarm point rating of 135 degree-F and a rate-of-rise alarm point of 15 degree-F per minute.
4. The heat detector shall be rated for ceiling installation at a minimum of 50 ft centers and be suitable for wall mount applications.

D. Standard Detector Bases, SIGA-SB/SIGA-SB4, CSFM 7300-1657:120

1. Provide standard detector mounting bases SIGA-SB suitable for mounting on North American 1-gang, 3-½" or 4" octagon box and 4" square box. The base shall, contain no electronics, support all Signature Series detector types and have the following minimum requirements:
  - a. Removal of the respective detector shall not affect communications with other detectors.
  - b. Terminal connections shall be made on the room side of the base. Bases, which must be removed to gain access to the terminals, shall not be acceptable.
  - c. The base shall be capable of supporting one (1) Signature Series SIGA-LED Remote Alarm LED Indicator. Provide remote LED alarm indicators where shown on the plans.

E. Relay Detector Bases, SIGA-RB / SIGA-RB4, CSFM 7300-1657:120



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1. Provide standard detector mounting bases SIGA-RB suitable for mounting on North American 1-gang, 3-½" or 4" octagon box and 4" square box. The base shall support all Signature Series detector types and have the following minimum requirements:
  - a. Removal of the respective detector shall not affect communications with other detectors.
  - b. Terminal connections shall be made on the room side of the base. Bases, which must be removed to gain access to the terminals, shall not be acceptable.
  - c. The relay shall be a bi-stable type and selectable for normally open or normally closed operation.
  - d. The position of the contact shall be supervised.
  - e. The relay shall automatically de-energize when a detector is removed.
  - f. The operation of the relay base shall be controlled by its respective detector processor. Detectors operating standalone mode shall operate the relay upon changing to alarm state. Relay bases not controlled by the detector microprocessor shall not be acceptable.
  - g. Form "C" Relay contacts shall have a minimum rating of 1 amp @ 30 Vdc and be listed for pilot duty.

F. Isolator Detector Bases, SIGA-IB/SIGA-IB4, CSFM 7300-1657:120

1. Provide isolator detector bases suitable for mounting on either 1-gang, 3-½ or 4-inch octagon box and 4-inch square box. The base shall, contain no electronics, support all Signature Series detector types and have the following minimum requirements:
  - a. The bases shall utilize a twist-lock design and provide screw terminals for all field wiring connections.
  - b. The base shall support all Signature series detector types.
  - c. Isolator bases shall limit number of modules or detectors that may be rendered inoperative by short-circuit fault on SLC loop segment or branch. In the event the Class A signaling line circuit on which the isolator bases are installed is shorted, each base shall open the SLC. Isolator bases shall then sequentially reconnect the isolated circuit segments until only the segment with the short is left out of the circuit, leaving the balance of the circuit operational.

G. Duct Detector, SIGA-SD, CSFM 3242-1657:223

1. Provide intelligent addressable photoelectric duct smoke detectors SIGA-SD. The analog photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. Systems using central intelligence for alarm decisions shall not be acceptable. The detector shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, aging and humidity. The information shall be stored in



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the integral processor and transferred to the analog loop controller for retrieval using a laptop.

2. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 0.79% to 2.46%. The duct detector shall be suitable for operation in the following environment:
  - a. Temperature: -20°F to 158°F (-29°C to 70°C)
  - b. Humidity: 0-93% RH, non-condensing
  - c. Air velocity: 100 to 4000 ft/min
3. Provide an air exhaust tube and an air sampling inlet tube, which extends into the duct air stream up to ten feet. The sampling tube can be installed with or without the cover in place and can be rotated in 45 degree increments to ensure proper alignment with the duct airflow.
4. Status LEDs shall remain visible through a clear assembly cover.
5. The unit shall contain a magnet-activated test switch.
6. One integral form C auxiliary alarm relay shall be provided. The relay contact shall be capable of being individually programmed from the control panel. The contact shall be rated for 2.0A at 30VDC
7. Provide Key-activated Remote Test station w/ integral remote alarm indicator SD-TRK where detectors must be accessed by ladder. (CSFM 7300-1657:226)

## 2.6 CONVENTIONAL INITIATING DEVICES

### A. General

1. All initiating devices shall be UL Listed for Fire Protective Service.
2. All initiating devices shall be of the same manufacturer as the Fire Alarm Control Panel specified to assure absolute compatibility between the devices and the control panels, and to assure that the application of the initiating devices is done in accordance with the single manufacturer's instructions.

### B. Weatherproof Pull Stations, MPSR1-S45W-GE, CSFM 7150-1657:236

1. Provide single action, single stage MPSR series fire alarm stations with terminals for wire connections rated for outdoor use.
2. Key reset shall be provided with keys identical to those required for the specified fire alarm panels, booster power supplies and other locked fire alarm cabinets.
3. Finish the station in red plated surface to inhibit corrosion.
4. Compatible factory weatherproof box w/ gasket shall be provided in all locations.
5. Pull Stations shall be individually monitored by addressable monitor module.

### C. Projected Beam Smoke Detector, EC-50R/100R, CSFM 7260-1657:233

1. The projected beam type smoke detector shall be a 4-wire 12/24 Vdc device used with UL listed separately supplied 4-wire control panels only.
2. The unit shall be listed to UL 268 and shall consist of an integrated transmitter and receiver.
3. The detector shall operate between a range of 15 and 330 ft.
4. The temperature range of the beam shall be -22 °F to 131 °F.



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5. The beam detector shall feature automatic gain control, which will compensate for gradual signal deterioration caused by dirt accumulation on the lenses.
6. The unit shall include a wall mounting bracket.
7. Testing shall be carried out using a calibrated test filter.
8. Provide wall mounted, EC-LLT, test station at ground level. Test stations shall include Power and Alarm LEDs with a key activated test switch on a single gang plate. (CSFM 7260-1657:234)
9. The unit shall be individually monitored for alarm trouble by addressable monitor module.

## 2.7 INTELLIGENT ADDRESSABLE MODULES

### A. General

1. Each remote device shall have a microprocessor with non-volatile memory to support its functionality and serviceability. Each device shall store as required for its functionality the following data: device serial number, device address, device type, personality code, date of manufacture, hours in use, time and date of last alarm, amount of environmental compensation left/used, last maintenance date, job/project number, current detector sensitivity values, diagnostic information (trouble codes) and algorithms required to process sensor data and perform communications with the loop controller.
2. Each device shall be capable of electronic addressing, either automatically or application programmed assigned, to support physical/electrical mapping and supervision by location. Setting a device's address by physical means shall not be necessary.
3. It shall be possible to address each Intelligent Signature Series module without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable. The personality of multifunction modules shall be programmable at site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller. Modules requiring EPROM, PROM, ROM changes or DIP switch and/or jumper changes shall not be acceptable. The modules shall have a minimum of 2 diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to 24 diagnostic codes, which can be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults.
4. The module shall be suitable for operation in the following environment:
  - a. Temperature: 32°F to 120°F (0°C to 49°C)
  - b. Humidity: 0-93% RH, non-condensing

### B. Single Input Module, SIGA-CT1, CSFM 7300-1657:121

1. Provide intelligent single input modules SIGA-CT1 for monitoring of PIV's, Fan Status, Tamper Switches, Flow Switches, Generator & Fire Pump Status, Preaction System Alarm or Trouble or any other dry contact required to be monitored.



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2. The Single Input Module shall provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation.
  3. The module shall be suitable for mounting on 2-1/2" deep 1-gang boxes and 1-1/2" deep 4" square boxes with 1-gang covers.
  4. The single input module shall support the following circuit types:
    - a. Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
    - b. Normally-Open Alarm Delayed Latching (Waterflow Switches)
    - c. Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
    - d. Normally-Open Active Latching (Supervisory, Tamper Switches)
- C. Dual Input Module, SIGA-CT2, CSFM 7300-1657:121
1. Provide intelligent dual input modules SIGA-CT2 for monitoring of sets of PIV's, Fan/Damper Status, Tamper Switches, Flow Switches, Generator & Fire Pump Status, Preaction System Alarm or Trouble or any other sets of dry contacts required to be monitored.
  2. The Dual Input Module shall provide two (2) supervised Class B input circuits each capable of a minimum of 4 personalities, each with a distinct operation.
  3. The module shall be suitable for mounting on 2-1/2" deep 1-gang boxes and 1-1/2" deep 4" square boxes with 1-gang covers.
  4. The dual input module shall support the following circuit types:
    - a. Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
    - b. Normally-Open Alarm Delayed Latching (Waterflow Switches)
    - c. Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
    - d. Normally-Open Active Latching (Supervisory, Tamper Switches)
- D. Signal Module, SIGA-CC1, CSFM 7300-1657:121
1. Provide intelligent single input signal modules SIGA-CC1 for activation of booster power supplies, audible/visual circuits, speaker circuits or for monitoring and communication of phone jacks.
  2. The Single Input (Single Riser Select) Signal Module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation.
  3. The module shall be suitable for mounting on 2-1/2" deep 2-gang boxes and 1-1/2" deep 4" square boxes with 2-gang covers.
  4. The single input signal module shall support the following operations:
    - a. Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25Vrms @50w or 70 Vrms @ 35 Watts of Audio)
    - b. Telephone Power Selector with Ring Tone (Fire Fighter's Telephone)
  5. When selected as a telephone power selector, the module shall be capable of generating its own "ring tone".
- E. Synchronized Signal Module, SIGA-CC1S, CSFM 7300-1657:121
1. Provide intelligent single input signal modules SIGA-CC1S for activation of booster power supplies and/or audible/visual circuits that require synchronization.



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2. The Single Input (Single Riser Select) Signal Module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation.
3. The module shall be suitable for mounting on 2-½" deep 2-gang boxes and 1-½" deep 4" square boxes with 2-gang covers.
4. The single input signal module shall support the following operations:
  - a. Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25Vrms @50w or 70 Vrms @ 35 Watts of Audio)
  - b. Telephone Power Selector with Ring Tone (Fire Fighter's Telephone)
5. Provides UL1971 auto-sync output for synchronizing multiple notification appliance circuits

F. Control Relay Module, SIGA-CR, CSFM 7300-1657:121

1. Provide intelligent control relay modules SIGA-CR for activation and/or shutdown of fans, dampers, door holder circuits, door locks, shunt trip, elevator recall or any other fail safe system requiring control or activation.
2. The Control Relay Module shall provide one form "R" dry relay contact rated at 2 amps @ 24 Vdc to control external appliances or equipment shutdown.
3. The control relay shall be rated for pilot duty and releasing systems.
4. The position of the relay contact shall be confirmed by the system firmware.
5. The control relay module shall be suitable for mounting on 2-½" deep 1-gang boxes and 1-½" deep 4" square boxes with 1-gang covers.

G. Isolator Module, SIGA-IM, CSFM 7300-1657:121

1. Provide addressable isolator modules at the locations shown on the drawings.
2. The module shall be suitable for mounting on 2-½" deep 1-gang boxes and 1-½" deep 4" square boxes with 1-gang covers.
3. In the event the Class A signaling line circuit on which the intelligent isolator module is installed is shorted, each module shall open the SLC. Isolator modules shall then sequentially reconnect the isolated circuit segments until only the segment with the short is left out of the circuit, leaving the balance of the circuit operational.

H. Manual Pull Station, SIGA-270, CSFM 7150-1657:129

1. Provide intelligent single action, single stage fire alarm stations SIGA-270. The fire alarm station shall be of metal construction with an internal toggle switch. Provide a locked test feature. Finish the station in red with silver "PULL IN CASE OF FIRE" lettering.
2. The manual station shall be suitable for mounting on 2-½" deep 1-gang boxes and 1-½" deep 4" square boxes with 1-gang covers.
3. Provide compatible surface mount red box, 276B-RSB, at all surface mount locations. Standard electrical boxes are not acceptable.



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2.8 NOTIFICATION APPLIANCES

A. General

1. All fire alarm appliances shall be UL Listed for Fire Protective Service.
2. All appliances shall be of the same manufacturer as the Fire Alarm Control Panel specified to insure absolute compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the single manufacturers' instructions.

B. Wall Strobes, Genesis G1 Series, CSFM 7125-1657:218

1. Provide wall mounted CLEAR lens strobes with WHITE body and "FIRE" markings.
2. The strobe shall be UL1971 listed have selectable 15, 30, 75 or 110 candela settings.
3. The strobe (15, 30, 75, 110) candela rating shall be view from the side window to verify the setting.
4. It shall be possible to change the strobe setting without removing the device from the wall
5. All strobes shall be synchronization to within 10 milliseconds for an indefinite period shall not require the use of separately installed remote synch modules.
6. The strobe shall be a low profile design and shall not protrude more than 1" off the wall. In-out screw terminals shall be provided for wiring.
7. The strobe shall be suitable for wall mounting and shall mount in a standard North American 1-gang box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.

C. Ceiling Strobes, Genesis GC Series, CSFM 7125-1657:219

1. Provide ceiling mounted CLEAR lens strobes with WHITE body and "FIRE" markings.
2. The standard ceiling strobe shall be UL1971 listed and have selectable 15, 30, 75 or 95 cd settings.
3. The high output ceiling strobe shall be UL1971 listed and have selectable 95, 115, 150 or 177 cd settings.
4. The strobe (15, 30, 75, 110) candela rating shall be view from the side window to verify the setting.
5. It shall be possible to change the strobe setting without removing the device from the ceiling.
6. All strobes shall be synchronization to within 10 milliseconds for an indefinite period shall not require the use of separately installed remote synch modules.
7. The strobe shall be a low profile design and shall not protrude more than 1.6" off the ceiling. In-out screw terminals shall be provided for wiring.
8. The strobe shall be suitable for ceiling mounting and shall mount in a standard 4" square 2-1/8" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.

D. Weatherproof Wall or Ceiling Strobes, Integrity CS405 Series, CSFM 7125-1657:184



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1. In and out screw terminals shall be provided for wiring.
2. Strobes shall provide synchronized flash.
3. Strobe output shall be determined as required by its specific location and application from a family of 15cd, 60cd, or 110cd devices
4. Strobes shall mount in a 1-gang box. For weatherproof application provide weatherproof wall boxes for mounting.

E. Wall Chimes, Genesis G1 Series, CSFM 7135-1591:231

1. The chime shall provide an 79 dBA sound output at 10 ft. when measured in reverberation room per UL-464.
2. The chime can also be set for low dB output with a jumper cut that reduces chime output by about 5 dB.
3. The chime shall have a selectable steady or synchronized temporal output.
4. It shall be a low profile design and shall not protrude more than 1" off the wall. In-out screw terminals shall be provided for wiring.
5. It shall be suitable for wall mounting and shall mount in a standard 1-gang box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.

F. Wall Chime-Strobes, Genesis G1 Series, CSFM 7125-1591:220

1. Provide wall mounted CLEAR lens strobes with WHITE body and "FIRE" markings.
2. The strobe shall be UL1971 listed have selectable 15, 30, 75 or 110 candela settings.
3. The strobe (15, 30, 75, 110) candela rating shall be view from the side window to verify the setting.
4. It shall be possible to change the strobe setting without removing the device from the wall
5. All strobes shall be synchronization to within 10 milliseconds for an indefinite period shall not require the use of separately installed remote synch modules.
6. The chime shall provide an 79 dBA sound output at 10 ft. when measured in reverberation room per UL-464.
7. The chime can also be set for low dB output with a jumper cut that reduces chime output by about 5 dB.
8. The chime shall have a selectable steady or synchronized temporal output.
9. It shall be a low profile design and shall not protrude more than 1" off the wall. In-out screw terminals shall be provided for wiring.
10. It shall be suitable for wall mounting and shall mount in a standard 1-gang box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.

G. Patient Room Dome Lights, 890 Series, CSFM 7300-1591:151

1. The lamp station shall be designed for placement on the wall or ceiling above the patient room door.
2. The lamp shall feature a large RED or WHITE translucent plastic lens w/ FIRE printed on them.
3. The lamp shall be available in 24v or 120v models.



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4. They shall be flush mounted over a standard one or two-gang electrical box.

H. Vibrating Bell, 439D-10AWR, CSFM 7136-1657:0150

1. Provide 10" surface weatherproof vibrating bell.
2. The bell shall be 24vdc.
3. Bell shall have a heavy duty cast housing with Red finish.
4. Weatherproof boxes (449) shall be provided for outdoor mounting.

2.9 ACCESSORY EQUIPMENT

A. Multi-Voltage Control Relays, MR Series, CSFM 7300-1004:101

1. General
  - a. Provide remote control relays connected to supervised ancillary circuits for control of fans, dampers, door releases, etc.
  - b. Relay contact ratings shall be SPDT and rated for 10 amperes at 115 Vac.
  - c. A single relay may be energized from a voltage source of 24 Vdc, 24 Vac, 115 Vac, or 230 Vac.
  - d. A red LED shall indicate the relay is energized.
  - e. A metal enclosure shall be provided.
2. MR-100 Series
  - a. Relay contact ratings shall be SPDT and rated for 10 amperes at 115 Vac.
3. MR-200 Series
  - a. Relay contact ratings shall be DPDT and rated for 10 amperes at 115 Vac.

B. Electromagnetic Door Holders, EST 1500 Series, CSFM 3550-1501:137

1. General - Electromagnetic door holders submitted for use must have written proof of their compatibility for the purposes intended. Such proof shall be in the form of documentation from all manufacturers that clearly states that their equipment (as submitted) is 100% compatible with each other for the purpose intended.
2. Wall Mounted, 1504/1505/1508/1509 Series
  - a. Provide flush, semi-flush or surface wall mounted electromagnetic door holder/releases selectable to 24 Vac/dc or 120 Vac as directed by the Consulting Engineer. Finish shall be brushed zinc.

C. Remote Booster Power Supplies, BPS6A/BPS10A, CSFM 7300-1657:229

1. Unit shall be a self-contained with 24Vdc power supply and batteries housed in its own locked enclosure. Keys provided shall be identical to the keys provided for all other fire alarm equipment provided.
2. Power supply shall be available in both 10 Amp or 6.5 Amp models and 110 Vac or 220Vac.



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3. On board LED indicators for each resident NAC, battery supervision, ground fault and AC power.
4. The power supply shall provide four (4) independent 3Amp NACs. Each circuit can be configurable as an auxiliary output.
5. Configurable for any one of three signaling rates: 120SPM; 3-3-3 temporal; or, continuous.
6. Two independent and configurable inputs switch selectable to allow correlation of the two (2) inputs and the four (4) outputs.
7. NACs shall be configurable for either four Class B or two Class A circuits.
8. The unit shall be compatible with SIGA-CC1S for synchronization of multiple power supplies without inter-connect wiring.
9. Brackets shall be provided inside the enclosure to allow mounting the signaling modules. All signaling modules shall be listed to be located inside the booster power supply enclosure.
10. A selectable dip switch shall enable built in synchronization for horns and strobes which may be used to synchronize downstream devices, as well as other boosters and their connected devices.

### PART 3 - - EXECUTION

#### 3.1 INSTALLATION CONDITIONS

- A. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation.
- B. The entire system shall be installed in a workmanlike manner, in accordance with approved manufacturer's wiring diagram.
- C. All fire alarm system wiring shall be in conduit. All system wiring shall be in accordance with manufacturer's recommendations and installed in an approved raceway.

#### 3.2 CONDUCTORS

- A. All circuits shall be rated power limited in accordance with NEC Article 760.
- B. All new system conductors shall be of the type(s) specified herein.
  1. All initiating circuit, signaling line circuit, AC power conductors, shield drain conductors and grounding conductors, shall be solid copper, stranded or bunch tinned (bonded) stranded copper.
  2. All wiring shall be color-coded throughout.
  3. Signaling Line Circuits



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- a. Shall be 18 AWG minimum multi-conductor jacketed twisted cable or as per manufacturer's requirements.
  - b. Circuit Integrity (CI) Cable: Provide as required to meet NFPA or Local Code requirements.
  - c. CI Cable shall meet article 760, power limited fire alarm service.
- 4. Initiating Device Circuits
  - a. 24 VDC IDC or Auxiliary function circuits shall be 18 AWG minimum or per manufacturer's requirements.
- 5. Notification Appliance Circuits –
  - a. Speaker: Twisted pair, not less than No. 16 AWG or as recommended by the manufacturer.
  - b. Horn-Strobe or Strobe: Non-Twisted pair, not less than No. 14 AWG or as recommended by the manufacturer.
- 6. 120 VAC circuits
  - a. Minimum 10 AWG for panel power circuits. Minimum 12 AWG for all other circuits.
  - b. Sharing of neutrals is prohibited. Each circuit shall have its own dedicated neutral conductor.
- 7. Fiber Optic Cable
  - a. Only glass filament cable permitted. Plastic filament fiber optic cables are not acceptable.
  - b. Multimode shall be 62.5/125 micron fiber optic cables with ST connectors used at all equipment terminations
  - c. Single Mode shall be 8.3 micron fiber optic cables with Duplex SC connectors used at all equipment terminations

### 3.3 CONDUIT RACEWAY

- A. All systems and system components listed to UL864 Control Units for Fire Protective Signaling Systems may be installed within a common conduit raceway system, in accordance with the manufacture's recommendations. System(s) or system components not listed to the UL864 standard shall utilize a separate conduit raceway system for each of the sub-systems.
- B. All system conduits shall be EMT, 3/4 -inch minimum, except for flexible metallic conduit used for whips to devices only, maximum length 6 feet, 3/4-inch diameter, minimum.
- C. All system conduits, which are installed in areas, which may be subject to physical damage or weather, shall be IMC or rigid steel, 3/4 -inch minimum.
- D. Conduits shall be sized according to the conductors contained therein. Cross sectional area percentage fill for system conduits shall not exceed 40%.



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- E. All fire alarm conduit systems shall be routed and installed to minimize the potential for physical, mechanical or by fire damage, and so as not to interfere with existing building systems, facilities or equipment, and to facilitate service and minimize maintenance.
- F. All conduits, except flexible conduit whips to devices, shall be solidly attached to building structural members, ceiling slabs or permanent walls. Conduits shall not be attached to existing conduit, duct work, cable trays, other ceiling equipment, drop ceiling hangers/grids or partition walls, except where necessary to connect to initiating, notification, or auxiliary function devices.
- G. All system conduits, junction boxes, pull boxes, terminal cabinets, electrical enclosures and device back boxes shall be readily accessible for inspection, testing, service and maintenance.
- H. All penetration of floor slabs and firewalls shall be sleeved (1" conduit minimum) fire stopped in accordance with all local fire codes.
- I. All junction box covers shall be painted red.

#### 3.4 INSTALLATION REQUIREMENTS

- A. All pull stations shall be mounted 48 inches above the finished floor, as measured on handle.
- B. All manual pull stations shall be flush mounted. Surface mounted pull stations shall be identified and requested prior to submittal. They shall only be allowed if approved by the Engineer prior to installation.
- C. All surface mounted devices shall be provided w/ manufacturer's listed back box.
- D. All new audio/visual devices shall be mounted at a minimum of 80 inches and no more than 96 inches above the finished floor, as measured on strobe center. Devices shall be mounted no less than 6 inches from the ceiling.
- E. No area smoke detectors shall be mounted within 36 inches of any HVAC supply, return air register or lighting fixture.
- F. No area smoke or heat detector shall be mounted within 12 inches of any wall.
- G. All fire alarm devices shall be accessible for periodic maintenance. Should a device location indicated on the Contract Drawings not meet this requirement, it shall be the responsibility of the installing contractor to bring it, in writing, to the attention of the Project Engineer. Failure to bring such issues to the attention of the Project Engineer shall be the exclusive liability of the installing Electrical Contractor.
- H. End of Line Resistors shall be furnished as required for mounting as directed by the manufacturer. Devices containing end-of-line resistors shall be appropriately labeled.



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Devices should be labeled so removal of the device is not required to identify the EOL device.

- I. All addressable modules shall be mounted within 36 inches of the monitored or controlled point of termination. This shall include, but is not necessarily limited to, fan shutdown, elevator recall, shunt trip, sprinkler status points, or door release. Label all addressable modules as to their function.
- J. Auxiliary relays shall be appropriately labeled on the exterior to indicate "FIRE ALARM SYSTEM" and their specific function (i.e. FAN S-1 SHUTDOWN).
- K. All AC power connections shall be to the building's designated emergency electrical power circuit and shall meet the requirements of NFPA 72 - The AC power circuit shall be installed in conduit raceway. The power circuit disconnect means shall be clearly labeled FIRE ALARM CIRCUIT CONTROL and shall have a red marking. The location of the circuit disconnect shall be labeled permanently inside the each control panel the disconnect serves.

### 3.5 TEST & INSPECTION

- A. All fire alarm testing shall be in accordance with NFPA 72.
- B. The system shall be pre-tested and documented prior to the final inspection by the AHJ. The owner shall be notified of the pretest 48 hours in advance and shall witness this test if desired.
- C. The pre-test shall include the following:
  - 1. All intelligent analog addressable devices shall be tested for current address, sensitivity, and user defined message.
  - 2. All wiring shall be tested for continuity, shorts, and grounds before the system is activated.
  - 3. Proper operation and execution of all its sequences
- D. At the final test and inspection, a factory-trained representative of the system manufacturer shall demonstrate to the Owner, his representative, and the local fire inspector all its sequence of operations and any additional tests required by the AHJ. In the event the system does not operate properly, the test may be terminated. Corrections shall be made and the testing procedure shall be repeated until it is acceptable to the Owner, his representatives and the fire inspector.

### 3.6 TRAINING

- A. The System Supplier shall schedule and present a documented formalized instruction for the building owner, detailing the proper operation of the installed System. One training segment shall be available at the completion of the project. A second training segment may be required within the warranty period.



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- B. The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.
- C. The instruction shall cover the schedule of maintenance required by NFPA 72 and any additional maintenance recommended by the system manufacturer.
- D. Instruction shall be made available to the Local Municipal Fire Department if requested by the Local Authority Having Jurisdiction.

3.7 EXTRA MATERIALS

- A. Provide 2% of each type of manual stations (minimum of two for each type).
- B. Provide six keys of each type.
- C. Provide 2% of each type of smoke and heat detector (minimum of two for each type).
- D. Provide 2% of each type of audible and visual indicating appliances (minimum of two for each type).

3.8 WARRANTY

- A. The contractor shall warranty all materials, installation and workmanship for one (1) year from date of acceptance, unless otherwise specified.
- B. A copy of the manufacturer's warranty shall be provided with closeout documentation and included with the operation and installation manuals.

END OF SECTION



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SECTION 31 10 00 - SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Clearing and protection of vegetation.
- B. Removal of existing debris.

1.02 RELATED REQUIREMENTS

- A. Section 011000 – Summary: Limitations on Contractor's use of site and premises.
- B. Section 015000 – Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- C. Section 024119 – Selective Demolition: Removal of built elements and utilities.
- D. Section 312300 - Earthwork: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

1.03 SUBMITTALS

- A. See Section 013300 – Submittal Procedures.
- B. Site Plan: Showing:
  - 1. Vegetation removal limits.
  - 2. Areas for temporary construction and field offices.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 SITE CLEARING

- A. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02 EXISTING UTILITIES AND BUILT ELEMENTS

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.



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- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Protect existing structures and other elements that are not to be removed.

### 3.03 VEGETATION

- A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, and planting beds, as indicated on drawings.
- B. Do not remove or damage vegetation beyond the limits indicated on drawings.
- C. Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain:
  - 1. At vegetation removal limits.
  - 2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
  - 3. Around other vegetation to remain within vegetation removal limits.
- D. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.
- E. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
  - 1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
  - 2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
  - 3. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
- F. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

### 3.04 DEBRIS

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.



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END OF SECTION



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SECTION 312300 - EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes (but Is not necessarily limited to):
  - 1. Rough grading earthwork.
  - 2. Excavating, trenching, and backfill.

1.02 DEFINITIONS

- A. Backfill: Soil materials used to fill an excavation.
  - 1. Initial Backfill: Backfill placed beside and over pipe or conduit in a trench, including haunches to support sides of pipe or conduit.
  - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Layer placed between the subbase course and asphalt paving
- C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- F. Engineered Fill: Fill material placed at the direction of the soils engineer.
- G. Excavation: Removal of material encountered above subgrade elevations.
  - 1. Additional Excavation: Excavation below subgrade elevations as directed by Owner's Project Manager. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
  - 2. Bulk Excavation: Excavations more than 10 feet in width and pits more than 30 feet in either length or width.
  - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Owner's Project Manager. Unauthorized excavation, as well as remedial work directed by Owner's Project Manager, shall be without additional compensation.
- H. Fill: Soil materials used to raise existing grades.
- I. Rock (project definition): Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material exceeding 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering or ripping, when permitted:



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1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-wide, short-tip-radius rock bucket; rated at not less than 120-hp flywheel power with bucket-curling force of not less than 25,000 lbf and stick-crowd force of not less than 18,700 lbf; measured according to SAE J-1179.
  2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp flywheel power and developing a minimum of 45,000-lbf breakout force; measured according to SAE J-732.
- J. Rock (ASTM definition): Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material 3/4 cu. yd. (0.57 cu. m) or more in volume that when tested by an independent geotechnical testing agency, according to ASTM D 1586, exceeds a standard penetration resistance of 100 blows/2 inches (97 blows/50 mm).
- K. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- L. Subbase Course: Layer placed between the subgrade and base course for asphalt paving, or layer placed between the subgrade and a concrete pavement or walk.
- M. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- N. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- 1.03 RELATED WORK SPECIFIED ELSEWHERE
- A. General Provisions Section – Testing and Inspection
  - B. Section 31 23 33 – Trenching, Backfilling and Compaction.
  - C. Section 33 05 00 - Installation of Buried Pipe.
  - D. Section 33 46 00 – Subdrainage.
- 1.04 SUBMITTALS
- A. Product Data: For the following:
    1. Drainage fabric.
    2. Separation fabric.
  - B. Samples: For the following:
    1. 10-lb. samples, sealed in airtight containers, of each proposed soil material from on-site or off-site borrow sources.
    2. 12-by-12-inch sample of drainage fabric.



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3. 12-by-12-inch sample of separation fabric.
  - C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance with the following requirements:
    1. Classification according to ASTM D 2487 of each on-site or off-site borrow soil material proposed for fill and backfill.
    2. Laboratory compaction curve according to ASTM D 1557 for each on-site or off-site borrow soil material proposed for fill and backfill.
    3. Laboratory compaction curve according to ASTM D 1557 for each on-site or off-site borrow soil material proposed for fill and backfill.
    4. Import fills should consist of granular soil with less than 35 percent passing the No. 200 sieve based on ASTM D 1140 and an Expansion Index (EI) of less than 20 based on ASTM D4829. [See Section 7.3.3 of Geotechnical Report]
  - D. Ground Improvement: Ground Improvement Specialty contractor shall submit plans and design calculations prior to construction for approval. The plans shall be reviewed by the Geotechnical Engineer of record for concurrence that they meet the design intent noted in the project geotechnical report. The ground improvement design package shall include Quality Control procedures to confirm the design bearing capacity and liquefaction potential meet the design intent. The Quality Control procedures shall include an indicator Modulus Test (MT) program and a ground improvement test section to indicate subsurface improvements by including pre- and post-improvement borings and/or CPTs along with liquefaction analyses to indicate that the post-ground improvement meets the design intent.
  - E. Blasting will not be permitted.
- 1.05 REFERENCES
- A. Standard Specifications for Public Works Construction ("Greenbook"), most current edition.
- 1.06 QUALITY ASSURANCE
- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.
- 1.07 PROJECT CONDITIONS
- A. Existing Utilities: Do not interrupt utilities serving existing facilities unless permitted in writing by Owner's Project Manager and then only after arranging to provide temporary utility services according to requirements indicated:
    1. Notify Owner's Project Manager not less than two weeks in advance of proposed utility interruptions.
    2. Do not proceed with utility interruptions without Owner's Project Manager's written permission.
    3. Contact utility-locator service for area where Project is located before excavating.



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- B. Cooperate with Owner and utility companies in maintaining respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
- C. Demolish and completely remove from site existing underground utilities to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Refer to Standard Specifications for Public Works Construction (SSPWC) "Greenbook" for recommendations.
- C. Unsatisfactory Soils: Refer to Standard Specifications for Public Works Construction (SSPWC) "Greenbook" for recommendations. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Backfill and Fill: Satisfactory soil materials.
- E. Subbase: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; with at least 90 percent passing a 1-1/2- inch sieve and not more than 12 percent passing a No. 200 sieve. Must meet Caltrans standards.
- F. Base: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve for Class II Base.
- G. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve. Must meet Caltrans standards.
- H. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- I. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2- inch sieve and 0 to 5 percent passing a No. 8 sieve.
- J. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.



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2.02 DRAINAGE FABRIC

- A. Non-woven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods.
  - 1. Grab Tensile Strength: 120 lbf; ASTM D 4632.
  - 2. Tear Strength: 40 lbf; ASTM D 4533.
  - 3. Puncture Resistance: 50 lbf; ASTM D 4833.
  - 4. Water Flow Rate: 150 gpm per sq. ft.; ASTM D 4491.
  - 5. Apparent Opening Size: No. 50; ASTM D 4751.

2.03 SEPARATION FABRIC

- A. Woven geotextile, specifically manufactured for use as a separation geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods.
  - 1. Grab Tensile Strength: 200 lbf; ASTM D 4632.
  - 2. Tear Strength: 75 lbf; ASTM D 4533.
  - 3. Puncture Resistance: 90 lbf; ASTM D 4833.
  - 4. Water Flow Rate: 4 gpm per sq. ft.; ASTM D 4491.
  - 5. Apparent Opening Size: No. 30; ASTM D 4751.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.02 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
  - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.



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2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.03 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.04 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavation to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.
  1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
- B. Classified Excavation: Excavation to subgrade elevations classified as earth and rock. Rock excavation will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.
  1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
    - a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
  2. Rock excavation includes removal and disposal of rock.
    - a. Do not excavate rock until it has been classified and cross-sectioned by Owner's Project Manager.

3.05 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  1. Excavation for Mechanical or Electrical Utility Structures: Excavate to required elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended for bearing surface.

3.06 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to required cross sections, elevations, and grades.
- B. Excavations shall be in accordance with the Standard Specifications for Public Works Construction (SSPWC) "Greenbook" prepared for this Project.

3.07 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to required gradients, lines, depths, and elevations.



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1. Beyond building perimeter, excavate trenches to allow installation of top of minimum of 24" below finished grade.
- B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise required to meet minimum cover.
  1. Clearance: unless otherwise shown on the drawings, 12 inches on each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
  1. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
  2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
  3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. Trench Depth: Excavate trenches 4 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
  1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.08 APPROVAL OF SUBGRADE

- A. Notify Owner's Project Manager when excavations have reached required subgrade.
- B. If Owner's Project Manager determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
  1. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- C. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.
- D. Reconstruct subgrades damaged by rain, accumulated water, or construction activities, as directed by Owner's Project Manager.

3.09 UNAUTHORIZED EXCAVATION

- A. Intentionally left blank.
- B. Fill unauthorized excavations under other construction or utility pipe as directed by Owner's Project Manager.



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3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Stockpile soil materials away from edge of excavations a minimum distance equal to the depth of excavation. Do not store within drip line of remaining trees.

3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
  - 1. Construction below finish grade including, where applicable, damp proofing, waterproofing, and perimeter insulation.
  - 2. Surveying locations of underground utilities for record documents.
  - 3. Inspecting and testing underground utilities.
  - 4. Removing concrete formwork.
  - 5. Removing trash and debris.
  - 6. Removing temporary shoring and bracing, and sheeting.
  - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.12 UTILITY TRENCH BACKFILL

- A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- B. Backfill trenches excavated under footings and within 18 inches of bottom of footings; fill with concrete to elevation of bottom of footings.
- C. Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.
- D. Place and compact initial backfill of subbase material, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit.
  - 1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
- E. Coordinate backfilling with utilities testing.
- F. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.
- G. Place and compact final backfill of satisfactory soil material to final subgrade.



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- H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 FILL

- A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.
- B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- C. Place and compact fill material in layers to required elevations as follows:
  - 1. Under grass and planted areas, use satisfactory soil material.
  - 2. Under walks and pavements, use satisfactory soil material.
  - 3. Under steps and ramps, use engineered fill.
  - 4. Under building slabs, use engineered fill.
  - 5. Under footings and foundations, use engineered fill.

3.14 MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill material on surfaces that are muddy, or contain frost or ice.
  - 2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF BACKFILLS AND FILLS

- A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Unless otherwise specified on the drawings or in the soils report, compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
  - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill material at 95 percent.
  - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material at 95 percent.
  - 3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material at 90 percent.



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3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
1. Provide a smooth transition between adjacent existing grades and new grades.
  2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
  3. Stripping. When fills are to be constructed over cultivated or fallowed land, the entire area upon which the fill is to be constructed shall first be cleared of vegetation and then smoothed with a blade grader. When fills are to be constructed over sodded surfaces, the sod shall be stripped to a depth of 2 inches. These smoothed or stripped surfaces shall then be rolled to the specified density required for fill prior to the fill material placement. Dispose of stripped material as waste and completely remove from the Project site.
  4. Conservation of Topsoil. Deposit topsoil in storage piles convenient to the areas which are subsequently to receive application of topsoil. Stockpile topsoil free of roots, stones and other undesirable material as specified in Paragraph 2.1 B above. Keep topsoil, when stored, separate from other excavated materials. Cover storage piles as required to prevent wind blown dust.
  5. Fills. Construct fills at the locations and to the lines and grades indicated on the Drawings. Insure that the completed fill corresponds to the shape of the typical sections shown on the Drawings or meets the requirements of that particular case. Use all approved material removed from the excavation in forming the necessary fill. All fill material shall be free from logs, stumps, sod, weeds, trash or other perishable material, and from all stones having a maximum dimension greater than 6 inches. No stones shall be permitted in the top 12 inches of fills. Place the material in successive horizontal layers not exceeding 8 inches in loose depth. Use a blade grader to keep fill material spread uniformly. Remove any soft sections, holes or depressions to required grades and refill with material as approved, and shape the entire area to line, grade, and cross section and thoroughly compact as specified. Contractor is responsible for adjustment of the moisture content of the fill material so that the specified compaction can be obtained. The rough grade for the entire Project site or portion thereof shall be approved by Owner's Project Manager before placement of any topsoil.
    - a. Subgrade Preparation. Subgrades for all drives, parking areas, sidewalks and other structures shall be shaped, dressed, moistened and compacted as specified. Test the subgrade for crown, elevation and density in advance of placing pavement.
    - b. Spreading of Topsoil:. Upon completion of rough grading, spread the stockpiled topsoil for a uniform depth of 6 inches, after settlement, over all areas graded not receiving other surfacing, just prior to the sodding or landscaping operation. Before spreading the topsoil, scarify the graded areas for a depth of 3 inches and repair all settlements and washes.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
1. Lawn or Unpaved Areas: Plus or minus 1 inch.



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2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Finished Grading. Accomplish uniformly smooth grading of all areas covered within the limits of the work, including excavated and filled sections and adjacent transition areas so that the finished surface is smooth, compacted and free from irregular surface changes. The degree of finish shall be that ordinarily obtainable from blade-grader operations except as otherwise specified. Finish all swales so as to drain readily.

1. Backfill material shall be the same as specified for fill and shall be placed and compacted as specified for fill unless otherwise noted.

D. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot (3-m) straightedge.

### 3.17 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place a layer of drainage fabric around perimeter of drainage trench as indicated. Place a 6-inch course of filter material on drainage fabric to support drainage pipe. Encase drainage pipe in a minimum of 12 inches of filter material and wrap in drainage fabric, overlapping sides and ends at least 6 inches.

1. Compact each course of filter material to 90 percent of maximum dry unit weight according to ASTM D 1557.

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade. Overlay drainage backfill with one layer of drainage fabric, overlapping sides and ends at least 6 inches.

1. Compact each course of filter material to 90 percent of maximum dry density according to ASTM D 1557.
2. Place and compact impervious fill material over drainage backfill to final subgrade.

### 3.18 BASE COURSES

A. Under pavements and walks, place base course on prepared subgrade and as follows:

1. Place base course material over subgrade.
2. Compact base courses at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
3. Shape base to required crown elevations and cross-slope grades.
4. When thickness of compacted base course is 6 inches or less, place materials in a single layer.
5. When thickness of compacted base course exceeds 6 inches, place materials in equal layers, with no layer more than 8 inches thick loose material or less than 4 inches thick when compacted.

### 3.19 DRAINAGE COURSE

A. Under slabs-on-grade, install drainage fabric on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.



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- B. Under slabs-on-grade, place drainage course on prepared subgrade and as follows, unless otherwise specified by the Geotechnical Engineer:
  - 1. Compact drainage course to required cross sections and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
  - 2. When compacted thickness of drainage course is 6 inches or less, place materials in a single layer.
  - 3. When compacted thickness of drainage course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

3.20 FIELD QUALITY CONTROL

- A. Testing Agency: Owner shall furnish a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design-bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Owner's Project Manager.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556 and ASTM D 2922 as applicable. Tests will be performed at the following locations and frequencies:
  - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
  - 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 100 feet or less of wall length, but no fewer than two tests.
  - 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench length, but no fewer than two tests.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.21 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.



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1. Scarify or remove and replace soil material to depth as directed by Owner's Project Manager; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.
- 3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS
  - A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property at Contractor's expense.
  - B. Disposal: Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Owner's Project Manager.
    1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property at Contractor's expense.

END OF SECTION



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SECTION 312333 - TRENCHING, BACKFILLING AND COMPACTION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Contractor shall comply with the requirement of this section which includes materials, testing and performance of trench excavation, backfilling and compacting, complete.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 330500 – Installation of Buried Pipe.
- B. Section 312300 – Earthwork.
- C. Section 321313 – Sitework Concrete

1.03 REFERENCES

- A. Standard Specifications for Public Works Construction (SSPWC) "Greenbook" most current edition.

1.04 SUBMITTALS

- A. Submit drawings showing excavation and shoring, bracing, or sloping for worker protection in accordance with the Special Provisions Section if required.
- B. Submit six (6) copies of a report from a testing laboratory verifying that material conforms to the specified gradations or characteristics for granular material or imported sand.

1.05 MEASUREMENT AND PAYMENT

- A. Payment for the work in this section will be included as part of the Contractor's unit price, total lump sum) for the various types of pipe as stated in the bid documents.

PART 2 - MATERIALS

2.01 PAVEMENT ZONES

- A. The pavement zone includes the asphaltic concrete and aggregate base pavement section placed over the trench backfill.



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2.02 TRENCH ZONE

- A. The trench zone includes the portion of the trench from the top of the pipe zone to the bottom of the street zone in paved areas or to the existing surface in unpaved areas.

2.03 PIPE ZONE

- A. The pipe zone shall include the full width of trench from the bottom of the pipe or conduit to a horizontal level above the top of the pipe, as specified below. Where multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipes to a horizontal level above the top of the highest or topmost pipe. Thickness of pipe zone above the highest top of pipe shall be 12 inches.

2.04 PIPE BASE

- A. The pipe base shall be defined as a layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width in which the pipe is bedded. Thickness of pipe base shall be four inches (4") below the lowest point of the pipe or bell.

2.05 SAND-CEMENT SLURRY BACKFILL

- A. Slurry is not permitted for trench backfill.

2.06 BACKFILL-PIPE ZONE AND PIPE BASE

- A. For ductile iron and PVC pipe the pipe base and pipe zone backfill material shall be imported sand as specified herein.

2.07 IMPORTED OR NATIVE SAND--PIPE ZONE AND PIPE BASE

- A. Imported sand shall have a minimum sand equivalent of 30 per State of California, Division of Highways Test "California 217" with 100% passing a 3/8" sieve and not more than 20% passing a 200-mesh sieve.
- B. Imported sand used in the pipe zone or for the pipe base shall have the following gradation:

<u>Percent passing</u> <u>Sieve Size</u>	<u>by Weight</u>
3/8 inch	100
No. 4	75 - 100
No. 30	12 - 50
No. 100	5 - 20
No. 200	0 - 15



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2.08 SAND-CEMENT SLURRY REFILL MATERIAL FOR FOUNDATION STABILIZATION IN PIPE ZONE

- A. Sand-Cement slurry fill in the pipe zone shall not be used unless approved by the Owner's Project Manager.
- B. Sand-Cement slurry shall consist of one (1) sack of Portland cement per cubic yard of sand and sufficient moisture for workability.

2.09 WATER FOR COMPACTION

- A. Water used in compaction shall have a maximum chloride concentration of 500 mg/l, a maximum sulfate concentration of 500 mg/l, and shall have a pH of 7.0 to 9.0. Water shall be free of acid, alkali or organic materials injurious to the pipe coatings.

PART 3 - EXECUTION

3.01 TESTING FOR COMPACTION

- A. Unless otherwise directed by the Owner's Project Manager, the Contractor will test for compaction as described below.
- B. Determine the density of soil in place by the sand cone method, ASTM D 1556.
- C. Determine the laboratory moisture-density relations of soils per ASTM D 1557.
- D. Determine the relative density of cohesionless soils by ASTM D 2049.
- E. Sample backfill materials by ASTM D 75.
- F. Express "relative compaction" as the ratio, expressed as a percentage; of the in place dry density to the laboratory maximum dry density.
- G. Compaction shall be deemed to comply with the specifications when no test falls below the specified relative compaction. The Contractor shall pay all associated costs of any re-testing of work not conforming to the specifications.

3.02 COMPACTION REQUIREMENTS

- A. Unless otherwise shown on the Drawings or specified in the soils report relative compaction in pipe zone shall be 95 percent.

3.03 MATERIAL REPLACEMENT

- A. Remove and replace any trenching and backfilling material, which does not meet the specifications, at the Contractor's expense.



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3.04 SHEETING, SHORING AND BRACING OF TRENCHES (IF REQUIRED)

A. GENERAL

1. Trenches shall have sheeting, shoring and bracing conforming to CAL/OSHA requirements and General Provisions. Lateral pressures for design of trench sheeting, shoring and bracing shall be based on type of soil exposed in the trench, groundwater conditions, surcharge loads adjacent to the trench and type of shoring that will be used in the trench.
2. The banks of trenches, where required to control trench width and protect adjacent structures, shall be sheeted and braced at no additional expense to the Owner. Where shoring, sheeting, bracing or steel strutted trench boxes are necessary, they shall be furnished, placed, maintained and, except as shown or specified otherwise, removed. Where damage is liable to result from the removal of the sheeting, then the sheeting will be required to be left in place and cut off if required or directed.
3. The design, planning, installation and removal, if required, of steel strutted trench boxes or sheeting, shoring, lagging, and bracing shall be accomplished in such a manner as to maintain the required excavation or trench section and to maintain the undisturbed state of the soils below and adjacent to the excavation.
4. The use of horizontal strutting below the barrel of the pipe or the use of the pipe as support for trench bracing will not be permitted. Sheet piling and timbers in trench excavations shall be withdrawn in a manner so as to prevent subsequent settlement of the pipe or additional backfill loading which might overload the pipe.
5. Following removal of shoring, bracing or steel strutted trench boxes, the space left due to such removal shall be backfilled immediately and the backfill compacted.

3.05 TRENCH EXCAVATION

A. GENERAL

1. Excavation of every description and of whatever substance encountered shall be performed, to the depths required. It may be necessary to increase or decrease the quantity of excavation because of unknown factors. The Engineer reserves the right to change the trench alignment from that indicated by 10 feet horizontally without additional expense to the Owner.

B. TRENCH WIDTHS

1. Maximum trench width in the pipe zone shall be as indicated on the plans. Trench width at the top of the trench will not be limited except where width of excavation would undercut adjacent structures and footings. In such case, width of trench shall be such that there is at least 18 inches between the top edge of the trench and the structure or footing.

C. GRADE

1. Excavate the trench to the depth required with allowance for pipe thickness and for pipe base or special bedding. If the trench is inadvertently excavated below the required grade, refill with imported sand any part of the trench excavated below the grade at no additional cost to the Owner. Place the refilling material over the full



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width of trench in compacted layers not exceeding six inches (6") to the established grade with allowance for the pipe base or special bedding.

D. EXCAVATION

1. Unless otherwise indicated, excavation shall be open cut. During excavation, material shall be stockpiled in an orderly manner, a distance back from the edges of the excavations specified by the governing safety agency before being wasted as specified. Caution shall be exercised in operating heavy equipment over pipelines. Leaks or breaks caused by the Contractor's operations shall immediately be repaired at no additional expense to the Owner and in a manner acceptable to the Engineer. The banks of excavated areas shall be controlled as is necessary to prevent movement of soil in areas supporting existing foundations, slabs, pole lines, underground power or telephone cables, trees, pipelines or other structures. If, as a result of the excavation or through fault or neglect of the Contractor, the earth or ground under or around such foundations, slabs, pole lines, underground power or telephone cables, trees, pipelines or other structures, slips or is otherwise disturbed, corrective measures shall be taken as directed at no additional expense to the Owner.
2. In the event the maximum allowable trench width is exceeded, the Contractor may be required, depending on the depth of trench, to improve the pipe bedding by utilizing concrete or other bedding materials as necessary to assure that the type of pipe installed can withstand the loads imposed by the backfill due to the depth of the trench.
3. The bottom of the trench shall be excavated to the depth required with proper allowance for pipe thickness, and for foundation stabilization and special bedding when required. Material containing rocks or cobbles larger than 2 inches in maximum dimension shall not be permitted within 6 inches of the pipe. Material of this type shall be removed from the bottom of the trench and replaced with backfill material. Parts of the trench excavated below grade shall be corrected with backfill as specified. The depth of trenches shall be as indicated.

3.06 DEWATERING

- A. Provide and maintain means and devices to remove and dispose of all water entering the trench excavation during the time the trench is being prepared for the pipe-laying, during the laying of the pipe, and until the backfill at the pipe zone has been completed. These provisions shall apply during 24 hours per day, seven days a week. Dispose of the water in a manner to prevent damage to adjacent property. Do not drain trench water through the pipeline under construction. Do not allow groundwater to rise around the pipe until jointing compound has set hard.
- B. Contractor shall notify the Owner's Project Manager 48 hours prior to commencement of dewatering. Any associated permits, discharge permits and fees associated with disposing water to the sewer system shall be at the contractors expense.



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3.07 LOCATION OF EXCAVATED MATERIAL

- A. During trench excavation, place the excavated material only within the working area. Do not obstruct any roadways or streets. Conform to federal, state and local regulations governing the safe loading of trenches with excavated material.

3.08 TRENCH BACKFILLING

- A. Backfill per the detailed piping specification for the pipe and per the following.
- B. Place the specified thickness of pipe base material over the full width of trench. Grade the top of the pipe base ahead of the pipe-laying to provide firm, uniform support along the full length of pipe.
- C. After pipe has been bedded, place pipe zone material simultaneously on both sides of the pipe, keeping the level of backfill the same on each side. Carefully place the material around the pipe so that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Use particular care in placing material on the underside of the pipe to prevent lateral movement during subsequent backfilling.
- D. No mechanical compaction of material placed within 12 inches of the outer surface of the pipe will be allowed.
- E. Push the backfill material carefully onto the backfill previously placed in the pipe zone. Do not permit free fall of the material until at least two feet (2') of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe.

3.09 BACKFILL COMPACTION

- A. Compact per the detailed specification.
- B. Compact trench backfill to the specified relative compaction. Compact by using mechanical compaction or hand tamping. Consolidation by jetting or flooding will be permitted at the Geotechnical Engineer's discretion. Maximum backfill lifts shall not exceed eight inches (8").

3.10 IMPORT OR EXPORT OF BACKFILL MATERIAL

- A. Excess excavation soil material shall be removed and disposed of by the Contractor off the project site at the Contract's expense. Excess soil material shall be disposed of in accordance with local regulations.
- B. Contractor shall be responsible, at no additional cost to the Owner, to import any required additional backfill material necessary to return all grades to the grade encountered at the beginning of construction or as shown on the contract Drawings.



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END OF SECTION



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SECTION 32 01 30 – OPERATION AND MAINTENANCE OF SITE IMPROVEMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Work Specified in this Section: Furnish all labor, material, equipment, and services required to maintain the landscape in an attractive condition as specified herein for a period of 90 calendar days.
- B. Related Work Specified in Other Sections:
  - 1. Section 32 84 00: Landscape Irrigation
  - 2. Section 32 90 00: Landscape Planting
- C. Definition: The word Architect as used herein shall refer to the Landscape Architect or the Owner's authorized representative.

1.2 QUALITY ASSURANCE

- A. The Contractor's representatives and employees shall be experienced in landscape maintenance.

1.3 90 CALENDAR DAY MAINTENANCE PERIOD

- A. The Contractor shall continuously maintain all areas involved in this Contract during the progress of work. Maintenance period shall not start until all elements of construction, planting, and irrigation for the entire project are in accordance with Plans and specifications.
  - 1. A prime requirement is that all lawn and groundcover areas shall have been planted and that all lawn areas shall show an even, healthy stand of grass seedlings or sod, either of which shall have been mowed twice. Maintenance period will not be shortened when this criteria is met, but may be lengthened if not met.
  - 2. The Contractor's maintenance period will be extended if the provisions required within the Plans and specifications are not fulfilled. Project may not be segmented into maintenance phases.
  - 3. The Contractor shall request a Pre-Maintenance inspection by the Owner and Architect at the completion of the installation process.
  - 4. The Maintenance Period shall begin upon successful completion of the Pre-Maintenance walk-through punch list and acceptance of the landscape installation by the Owner.
  - 5. If such criteria are met to the satisfaction of the Owner, a field notification will be issued to the Contractor to establish the effective beginning date of the maintenance period.



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- B. The Maintenance Period continues for 90 calendar days until final acceptance of the work by the Owner. Improper maintenance or poor condition of planting at the termination of the scheduled maintenance period may cause postponement of the final completion date of the Contract.
- C. Any day when the Contractor fails to adequately maintain planting, replace unsuitable plants or do weed control or other work, as determined necessary by the Owner, will not be credited as one of the maintenance period working days.

#### 1.4 GUARANTEE AND REPLACEMENT

- A. Guarantee: All plant material installed under the contract shall be guaranteed for a period of one year from the Start of the Maintenance Period. Plants found to be dead or in poor condition due to faulty materials or workmanship, as determined solely by the Architect, shall be replaced by the Contractor at his expense.
  - 1. Replacement: Materials found to be dead, missing, or in poor condition during the Maintenance period shall be replaced immediately.
  - 2. The Architect shall be the sole judge as to the condition of material.
  - 3. The Contractor shall replace material rejected during the Guarantee period within fifteen (15) days of written notification by the Owner.

#### 1.5 OBSERVATION VISITS

- A. The Contractor shall request progress visits from the Architect at least 72 hours in advance of anticipated visits. Normal observation visits are as follows:
  - 1. Immediately prior to the commencement of the work in this section.
  - 2. Completion of first 90 days of maintenance.
  - 3. Final acceptance.

#### 1.6 FINAL ACCEPTANCE OF THE PROJECT

- A. Prior to the date of the final observation visit, the Contractor shall acquire from the Architect-approved reproducible Plans and record (from the job record set) all changes made during construction, label these Plans "Record Drawings", and deliver to the Architect for review and approval.
- B. Prior to the date of final inspection, the Contractor shall deliver to the Architect a written "Landscape and Irrigation Guarantee" as required herein.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. All materials used shall either conform to landscape specifications in other sections or shall otherwise be acceptable to the Owner.



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- B. The Owner shall be given a monthly record of all herbicides, insecticides, and disease control chemicals used. Failure to provide such a record will continue maintenance period until compliance occurs.

## PART 3 - EXECUTION

### 3.1 MAINTENANCE

- A. Maintenance shall be performed according to the following standards:
1. All areas shall be weeded and cultivated at intervals of not more than ten (10) days.
  2. Watering, mowing, rolling, edging, trimming, fertilization, spraying, and pest and rodent control, as may be required, shall be included in the maintenance period.
  3. Street gutters shall be cleaned as part of the maintenance program.
  4. The Contractor shall be responsible for maintaining adequate protection of the area.
    - a. Damaged areas shall be repaired at the Contractor's expense.
  5. Between the 15th day and the 20th day of the maintenance period, the Contractor shall reseed and re-sod all spots or areas within the lawn where normal turf growth is not evident.
- B. The Contractor shall be responsible for reporting to the Owner conditions beyond his control that prevent or have negative impact on the work required herein.

### 3.2 TREE AND SHRUB CARE

- A. Watering
1. Apply enough irrigation water so that moisture penetrates throughout root zone and only as frequently as necessary to maintain healthy growth.
    - a. Do not maintain soils in a constantly wet condition.
    - b. Contractor shall be responsible for familiarizing himself with the particular water requirements for the various plantings and shall be responsible for setting and maintaining the automatic controller to optimum minimum levels.
    - c. Damage to the plantings caused by over-watering or under-watering shall be the responsibility of the Contractor to replace at no cost to Owner.
  2. Maintain a water basin around newly planted plants so that water can be applied to moisturize throughout the root zone. At the end of the maintenance period these basins shall be flattened out to match surrounding grades.
  3. If hand-watering, use a fan spray nozzle to break the water force.
- B. Tree Pruning
1. Nursery grown trees will not normally require pruning for the first year. Prune trees only if directed by Architect or Owner, and only for these purposes:



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- a. selection and development of permanent scaffold branches that have a vertical spacing of from 18" to 48" and radial orientation so as not to cross each other,
    - b. elimination of diseased or damaged growth,
    - c. elimination of narrow V-shaped branch forks that lack strength,
    - d. reduction of toppling and wind damage by thinning out crowns,
    - e. maintenance of growth within space limitations,
    - f. maintenance of natural appearance,
    - g. Balancing of crown-to-root ratio.
  2. Under no circumstances will stripping of lower branches ("rising up") of young trees be permitted.
    - a. Lower branches shall be retained in a "tipped-back" or pinched condition with as much foliage as possible to promote caliper trunk growth (tapered trunk).
    - b. Lower branches can be cut flush with trunk only after the tree is able to stand erect without staking or other support.
  3. Evergreen trees shall be thinned out and shaped when necessary to prevent wind and storm damage. The primary pruning of deciduous trees shall be done during the dormant season. Damaged trees or those that constitute health or safety hazards shall be pruned at any time of the year as required.
- C. Shrub Pruning
1. The objectives of shrub pruning are the same as for trees. Shrubs shall not be clipped into balled or boxed forms unless such is required by the design.
  2. All pruning cuts shall be made to lateral branches or buds or flush with the trunk. "Stubbing" will not be permitted.
- D. Staking and Guying: Stakes and guys shall remain in place until final acceptance and are to be continuously inspected and adjusted to prevent girdling of trunks or branches and to prevent rubbing that causes bark wounds and to allow trees to sway freely. Stakes and guys are to be removed when trees become sufficiently well rooted or after one year. When stakes or guys are removed, tree heads may be thinned to reduce wind load.
- E. Weed Control: Keep all areas, including basins and areas between plants, free of weeds.
1. Use recommended legally approved herbicides only when mechanical removal methods are not feasible.
  2. Avoid frequent soil cultivation next to trees or shrubs that destroys shallow roots.
  3. Use mulches to help prevent weed seed germination.
- F. Pest and Disease Control: Maintain control of insect and rodent infestations. The preferred method of control shall be biological control, or with non-toxic, biodegradable, organic materials. If stronger materials are needed, only materials that are recommended by a licensed Pest Control Advisor and are EPA approved and regulated shall be used. Only registered and licensed Pest Control Operators shall



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apply insecticide or chemical applications. Notify Owner a minimum of five (5) working days before chemical applications.

G. Fertilization

1. Fertilize all planting areas at 30-day intervals, with fertilizer and at rate as recommended by Soils Report.
  - a. Avoid applying fertilizer to root balls and bases of main stems
  - b. Spread fertilizer evenly around plants to drip line.
  - c. Distribute fertilizer evenly over turf or groundcover areas to avoid patchy coloration.

H. Replacement of Plants: Replace dead, dying, and missing plants with plants of a size, condition, and variety acceptable to Architect or Owner at Contractor's expense.

3.3 GROUND COVER CARE

- A. Weed Control: Control weeds preferably with mechanical methods, and also with preemergent herbicides and selective systemic herbicides. Hoe weeds as little as possible since this may result in plant damage. Foot traffic in planted areas shall be minimized, and soil compaction shall be loosened immediately.
- B. Watering: Water enough so that moisture penetrates throughout root zone and only as frequently as necessary to maintain healthy growth.
  1. Do not maintain soils in a constantly wet condition.
  2. Contractor shall familiarize himself with the particular water requirements for the planting and shall be responsible for setting and maintaining the automatic controller to optimum minimum levels.
  3. Damage to the planting caused by over-watering or under-watering shall be the responsibility of the Contractor to replace.
- C. Trash: Remove trash weekly. Remove debris, clippings or branches produced by maintenance activities within 8 hours.
- D. Edging and Trimming: Edge ground cover to keep in bounds and trim top growth as necessary to achieve an overall even appearance.
- E. Replacement: Replace dead and missing plants at Contractor's expense.

3.4 IRRIGATION SYSTEM

- A. System Inspection: Contractor shall continuously check all systems for proper operation. Lateral lines shall be flushed out after removing the last sprinkler head or two at each of the lateral. All heads are to be continuously adjusted as necessary for proper coverage and to eliminate over-spray on buildings or paving. Contractor's regular maintenance personnel shall test, observe, and adjust each sprinkler system no less than once per month.



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- B. Controllers: Set and program automatic controllers for seasonal water requirements and minimum optimum water use. Give Owner's representative a key to controllers and instructions on how to turn off system in case of emergency.
- C. Repairs: Repair all damage to irrigation system at Contractor's expense. Repairs shall be made within one watering period.

END OF SECTION



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SECTION 32 01 90 – TREE AND SHRUB PRESERVATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the protection and trimming and root pruning of trees that interfere with, or are affected by, execution of the Work, whether temporary or new construction.

1.2 RELATED WORK NOT IN THIS SECTION:

- A. Section 32 90 00: Landscape Planting
- B. Section 32 91 19: Finish Grading

1.3 SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of landscape architects and owners, and other information specified.
- B. Certification from a qualified arborist that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
- C. Maintenance recommendation from a qualified arborist for care and protection of trees affected by construction during and after completing the Work.

1.4 QUALITY ASSURANCE

- A. Arborist Qualifications: An arborist certified by the International Society of Arboriculture or licensed in the jurisdiction where Project is located.
- B. Tree Pruning Standards: Comply with ANSI A300, "Trees, Shrubs, and Other Woody Plant Maintenance--Standard Practices," unless more stringent requirements are indicated.
- C. Pre-installation Conference: Before starting tree protection and trimming, meet with representatives of authorities having jurisdiction, Owner, Landscape Architect, consultants, and other concerned entities. Review tree protection and trimming procedures and responsibilities.



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## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Drainage Fill: Selected crushed stone, or crushed or uncrushed gravel, washed, ASTM D 448, Size 24, with 90 to 100 percent passing a 2-1/2-inch sieve and not more than 10 percent passing a 3/4-inch sieve.
- B. Topsoil: Fertile, friable, surface soil, containing natural loam and complying with ASTM D 5268. Provide topsoil that is free of stones larger than 1 inch in any dimension and free of other extraneous or toxic matter harmful to plant growth. Obtain topsoil only from well-drained sites where soil occurs in depth of 4 inches or more; do not obtain from bogs or marshes.
- C. Filter Fabric: Manufacturer's standard, non-woven, pervious, geotextile fabric of polypropylene, nylon, or polyester fibers.
- D. Chain Link Fence: Metallic-coated steel chain link fence fabric, 0.120-inch- diameter wire size; 72 inches high, minimum; line posts, 1.9 inches in diameter; terminal and corner posts, 2-3/8 inches in diameter; top rail, 1-5/8 inches in diameter; bottom tension wire, 0.177 inch in diameter; with tie wires, hog ring ties, and other accessories for a complete fence system.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Before construction begins, fertilize affected trees to improve tree vigor and health. Soil analysis testing should be completed to assure fertilization with the appropriate fertilizer products.
- B. Temporary Fencing: Install temporary fencing located at or outside the drip line of trees.
- C. Protect tree root systems from damage due to noxious materials caused by runoff or spillage while mixing, placing, or storing construction materials. Protect root systems from flooding, eroding, or excessive wetting caused by dewatering operations.
- D. Do not store construction materials, debris, or excavated material within the drip line of remaining trees. Do not permit vehicles or foot traffic within the drip line; prevent soil compaction over root systems.
- E. Do not allow fires under or adjacent to remaining trees or other plants.

### 3.2 EXCAVATION

- A. Do not excavate within drip line of trees.



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- B. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks and comb soil to expose roots.
  - 1. Cut roots approximately 3 inches back from new construction.
  - 2. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Protect roots from damage until they are permanently relocated and covered with soil.
- C. Where utility trenches are required within drip line of trees, tunnel under or around roots by drilling, auger boring, pipe jacking, or digging by hand.
- D. Root Pruning: Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots with sharp pruning instruments; do not break or chop.

### 3.3 TREE PRUNING

- A. Prune tree canopies and branches at the direction of the project arborist to remove any dead or broken branches, and to provide the necessary clearances for the construction equipment.
- B. Root prune existing street trees to prevent sidewalk and curb damage.
- C. Prune remaining trees to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by qualified arborist.
- D. Pruning Standards: Prune trees according to ANSI A300 as follows:
  - 1. Crown cleaning.
  - 2. Crown thinning.
  - 3. Crown reduction.
- E. Cut branches with sharp pruning instruments; do not break or chop.

### 3.4 TREE REPAIR AND REPLACEMENT

- A. Promptly repair trees damaged by construction operations within 24 hours. Treat damaged trunks, limbs, and roots according to written instructions of the qualified arborist.
- B. Remove and replace dead and damaged trees that the qualified arborist determines to be incapable of restoring to a normal growth pattern.
- C. Provide new trees of the same size and species as those being replaced; plant and maintain as specified in Division 32 Section "Landscape Planting."



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3.5 SOIL AERATION

- A. Aerate surface soil compacted during construction, 10 feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch- diameter holes a minimum of 12 inches deep at 24 inches on center. Backfill holes with an equal mix of augured soil and sand.

3.6 DISPOSAL OF WASTE MATERIALS

- A. Burning is not permitted.
- B. Disposal: Remove excess excavated material, displaced trees, and excess chips from Owner's property.

END OF SECTION 32 01 90



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SECTION 321123 - AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate base course.
- B. Paving aggregates.

1.02 RELATED REQUIREMENTS

- A. Section 31 23 00 – Earthwork: Preparation of site for base course, compacted fill under base course.
- B. Section 32 12 16 – Asphalt Concrete Paving: Finish and binder asphalt courses.
- C. Section 32 13 13 – Sitework Concrete: Finish concrete surface course.
- D. Section 33 05 13 – Manholes and Structures: Manholes including frames.

1.03 REFERENCE STANDARDS

- A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses 2017.
- B. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18 in.) Drop 2018.
- C. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates 2014.
- D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)) 2012, with Editorial Revision (2015).
- E. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method 2007.
- F. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN m/m<sup>3</sup>)) 2012, with Editorial Revision (2015).



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- G. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method 2015.
- H. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2017.
- I. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils 2017, with Editorial Revision (2018).
- J. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) 2017a.

#### 1.04 SUBMITTALS

- A. See Section 013300 - Submittal procedures.
- B. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- C. Compaction Density Test Reports.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Coarse Aggregate Type Caltrans Class 2: Natural washed stone; free of shale, clay, friable material and debris.
  - 1. Graded in accordance with Standard Specifications for Public Works Construction, "Greenbook".
- B. Blended Aggregate Type Caltrans Class 2: Pit run stone; free of shale, clay, friable material and debris.
- C. Fine Aggregate Type: Sand; complying with Standard Specifications for Public Works Construction, "Greenbook".

#### 2.02 SOURCE QUALITY CONTROL

- A. Where aggregate materials are specified using ASTM D2487 classification, test and analyze samples for compliance before delivery to site.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

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AGGREGATE BASE COURSE  
32 11 23- 2



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- A. Verify that survey bench marks and intended elevations for the work are as indicated.

### 3.02 PREPARATION

- A. Do not place aggregate on soft, muddy, or frozen surfaces.

### 3.03 INSTALLATION

- A. Spread aggregate over prepared substrate to a total compacted thickness as indicated on plans.
- B. Place aggregate in maximum 4 inch layers and roller compact to specified density.
- C. Level and contour surfaces to elevations and gradients indicated.
- D. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.
- E. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

### 3.04 FIELD QUALITY CONTROL

- A. See Section 014000 – Quality Requirements, for general requirements for field inspection and testing.
- B. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556, ASTM D2167 or ASTM D6938.
- C. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- D. Proof roll compacted aggregate at surfaces that will be under slabs-on-grade.

### 3.05 CLEANING

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

## **A. END OF SECTION**



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SECTION 32 12 16 – ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included:
  - 1. Constructing one or more surface courses composed of a mixture of aggregate, filler if required, and asphalt concrete material, placed on a prepared base.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. C 117 – Test Method for Material Finer than 75 mm (Number 200) Sieve in Mineral Aggregates by Washing.
  - 2. C 131 – Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - 3. C 136 – Method for Sieve Analysis of Fine and Coarse Aggregates.
  - 4. D 977 – Standard Specification for Emulsified Asphalt.
  - 5. D 1559 – Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
  - 6. D 3381 – Specification for Viscosity Graded Asphalt Cement for Use in Pavement Construction.
  - 7. D 4318 – Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
  - 8. State of California, Department of Transportation (Caltrans), Standard Specifications, most current edition.
  - 9. Pavement markings.
- B. Standard Specifications for Public Works Construction, most current edition.

1.03 SUBMITTALS

- A. Job Mix Formula: Before producing asphalt concrete mixture, submit a job mix formula for each mixture to the Owner for approval. Should a change in source of material be proposed, or should a job mix formula prove unsatisfactory, submit a new job mix formula for approval.
  - 1. Each job mix formula submitted shall propose definite single values for:
    - a. The percentage of aggregate passing each specified sieve, based on dry weight of aggregate. These percentages shall be within the range shown in Part 2 of this section.
    - b. The percentage of asphalt concrete material to be added, based on the total weight of the mixture, and the percentage of any stabilizing agent such as lime, portland cement, or antistriper agent.
  - 2. In addition, the job mix formula shall provide a mixture having a minimum wet retained strength of 125 psi, as determined by AASHTO T165 82, and an index of retained strength of not less than 70 percent.



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- B. Samples: Asphalt cement, 1 quart minimum sample for each load delivered.
- C. Certificates:
  - 1. Certification from supplier that asphalt cement is of correct type and meets requirements of this section. Two copies will be required for each load.
  - 2. Two copies of certified weight ticket from supplier for each load of asphalt cement.
  - 3. Two copies of certified weight tickets for each load of asphalt concrete.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Asphalt Concrete Delivery.
  - 1. Transport the mixture from the mixing plant to the point of use in vehicles having tight bodies previously cleaned of all foreign materials.
  - 2. Treat bodies as necessary to prevent material from sticking to the bodies.
  - 3. Cover each load with canvas or other suitable material of sufficient size and thickness to protect the asphalt mixture from the weather.

1.05 PROJECT CONDITIONS

- A. Apply mixture only during daylight hours; when air temperature is 50 degrees Fahrenheit (F) or higher; when surfaces to be paved are dry and free of frost, snow, or ice; and when precipitation is not imminent.

PART 2 - PRODUCTS

2.01 AGGREGATE

- A. The aggregate shall meet the general and physical requirements of ASTM C131.
- B. Coarse aggregate is defined as that portion of a representative sample retained on a No. 8 sieve, whereas fine aggregate is defined as that portion passing the No. 8 sieve.
- C. The aggregates for the mixture shall be graded and combined in such proportions that the resulting composite blend meets the requirements of the job mix formula. The job mix formula with the allowable tolerances shall be within the master range set forth in the following table.

Sieve Designation	Percent Passing
3/4-inch	100
3/8-inch	60 – 85
No. 4	40 – 70
No. 8	28 – 52
No. 30	14 – 30
No. 200	3 – 12



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2.02 ASPHALT CONCRETE MATERIAL

- A. Asphalt cement, viscosity grade PG 64-10, AASHTO M226 80, Table 1. The grade may be changed one step by the Engineer at no additional expense to the Owner. The approximate percent of asphalt cement to be added to the mix shall be 5 to 7 percent based on total weight of mixture. The final percentage will be determined from the job mix formula for each mixture specified. The asphalt cement used on the project shall be of the same grade and from the same supplier as that used and approved in the job mix formula.
- B. Prime/tack coat shall be Type SC 70 liquid asphalt conforming to the requirements of the Caltrans Standard Specifications Section 93 or asphalt emulsion conforming to the requirements of Caltrans Standard Specifications Section 94.
- C. Asphalt concrete surfacing shall conform to the requirements of Caltrans Standard Specifications Section 39. Mineral aggregate shall be ½ inch maximum size, Type B.

2.03 FILLER

- A. If filler is required, the filler material shall meet the requirements of AASHTO M 17 77.

PART 3 - EXECUTION

3.01 EQUIPMENT

- A. Plant, hauling, placing, and rolling equipment shall be adequate to ensure uniformity and continuity of operations and be in good operating condition capable of performing according to manufacturer's specifications. The Contractor may, at his option, use the type plant he desires, provided the equipment meets the following requirements.
- B. Requirements for All Plants:
  - 1. Equipment for Preparation of Asphalt Concrete Material: Tanks for the storage of asphalt concrete material shall be equipped to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that flame will not be in contact with the tank. The circulating system for the asphalt concrete material shall be designed to ensure proper and continuous circulation during the operating period. Provision shall be made for measuring and sampling material in storage tanks.
  - 2. Feeder for Dryer: The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the dryer to obtain uniform production and temperature.
  - 3. Dryer: The plant shall include a dryer or dryers that continuously agitate the aggregate during the heating and drying process.
  - 4. Screens: Aggregate gradation control shall be provided either with plant screens or screenless plants in accordance with the following methods:



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- a. METHOD A: Plant screens shall screen the hot aggregate to the specified sizes and proportions and have normal capacities in excess of the full capacity of the mixer.
  - b. METHOD B: Screenless plants with cold feed control shall have the cold aggregate separated and stored in separate coarse aggregate and fine aggregate stockpiles.
5. Hot Aggregate Bins: Pugmill plants shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to ensure separate and adequate storage of appropriate fractions of the hot mineral aggregates. Separate dry storage shall be provided for filler or hydrated lime when used, and the plant shall be equipped to feed such material into the mixer. Each bin shall be provided with overflow pipes, of such size and at such locations as to prevent backing up of material into other compartments or bins. Each compartment shall be provided with its individual outlet gate, constructed so that when closed there shall be no leakage. The gates shall cut off quickly and completely. Bins shall be so constructed that samples can be readily obtained. Bins shall be equipped with adequate tell tale devices to indicate the position of the aggregates in the bins at the lower quarter points.
6. Asphalt Concrete Control Unit: Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of asphalt concrete material in the mix. Means shall be provided for checking the quantity or rate of flow of asphalt concrete material into the mixer.
7. Thermometric Equipment: An armored thermometer of adequate range shall be fixed in the asphalt concrete feed line at a suitable location near the charging valve at the mixer unit. The plant shall also be equipped with an approved temperature measuring apparatus placed at the discharge chute of the dryer.
8. Emission Control: Dust, smoke, or other contaminants shall be controlled by appropriate devices at the plant site to meet air pollution requirements.
9. Commercial Binders or Fillers: When materials are to be used that require the mixing of commercial binders or fillers with the aggregate, a central mixing plant of the twin-pugmill type will be required. Other methods that ensure a thorough and homogeneous mixture will be permitted on written approval.
- C. Requirements for Batching Plants:
1. Weight Box or Hopper: The equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that material is not allowed to leak into the mixer while a batch is being weighed.



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2. Asphalt Concrete Control: The equipment used to measure the asphalt concrete material shall be accurate to plus or minus 0.5 percent. The asphalt concrete material bucket shall be non-tilting type with a loose sheet metal cover. The length of the discharge opening or spray bar shall be not less than  $\frac{3}{4}$  the length of the mixer and it shall discharge directly into the mixer. The asphalt concrete material bucket, its discharge valve or valves, and spray bar shall be adequately hosted. Steam jackets, if used, shall be efficiently drained and all connections shall be so constructed that they will not interfere with the efficient operation of the asphalt concrete scales. The capacity of the asphalt concrete material bucket shall be at least 15 percent in excess of the weight of asphalt concrete material required in any batch. The plant shall have an adequately heeled, quick acting, nondrip, charging valve located directly over the asphalt concrete material bucket.

The indicator dial shall have a capacity of at least 15 percent in excess of the quantity of asphalt concrete material used in a batch. The dial shall be in full view of the mixer operator. The flow of asphalt concrete material shall be controlled so that it will begin when the dry mixing period is over. All of the asphalt concrete material required for one batch shall be discharged not more than 15 seconds after the flow has started. The size and spacing of the spray bar openings shall provide a uniform application of asphalt concrete material the full length of the mixer. The section of the asphalt concrete line between the charging valve and the spray bar shall be provided with a valve and outlet for checking the meter when a metering device is substituted for a asphalt concrete material bucket.

3. Mixer: The batch mixer shall be an approved type capable of producing a uniform mixture within the job mix tolerances. If not enclosed, the mixer box shall be equipped with a dust hood to prevent loss of dust.

The clearance of blades from all fixed and moving parts shall not exceed 1 inch unless the maximum diameter of the aggregate in the mix exceeds  $1\frac{1}{4}$  inches, in which case the clearance shall not exceed  $1\frac{1}{2}$  inches.

- D. Hauling Equipment: Trucks used for hauling asphalt concrete mixtures shall have tight, clean, smooth metal beds that have been thinly coated with a minimum amount of paraffin oil, lime solution, or other approved material to prevent the mixture from adhering to the beds. Each truck shall have a cover of canvas or other suitable material of such size as to protect the mixture from the weather.
- E. Rollers: Rollers shall be of the steel wheel, vibratory, pneumatic tire type, or combination, capable of reversing without backlash. Steel wheel rollers other than vibrating shall be capable of exerting a force of not less than 250 psi of width of the roller. Vibrating steel wheel rollers shall have a minimum weight of 6 tons.
- F. Pneumatic-tired rollers shall have smooth tread tires of equal size that will provide a uniform compaction pressure for the full width of the roller and shall be capable of exerting a ground pressure of at least 80 psi.



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3.02 SAWCUTTING, REMOVAL, AND PREPARATION OF EXISTING PAVEMENT

- A. Existing asphalt pavement to be removed shall be cut by a wheel cutter or other device capable of making a neat, reasonably straight and smooth cut without damaging adjacent pavement that is not to be removed.
- B. The existing pavement shall be saw cut and trimmed after placement of required base course material and just prior to placement of asphalt concrete for pavement replacement, and the trimmed edges shall be painted with a coating of prime coat immediately prior to constructing the new abutting asphalt pavements.
- C. All existing aggregate base material and asphalt concrete removed, and any excess new material shall be hauled away from the project site and legally disposed of by the Contractor.

3.03 APPLICATION

- A. Conditioning of Existing Surface: When the surface of the existing pavement or old base is irregular, it shall be brought to uniform grade and cross section as directed.
- B. Paint contact surfaces of curbing, gutters, manholes, and other structures with a thin, uniform coating of asphalt concrete tack/primer coating emulsion before placing the asphalt concrete mixture against them.

3.04 MIXING

- A. Combine aggregates in the mixer in the amount of each fraction of aggregates required to meet the job mix formula. The asphalt concrete material shall be measured or gauged and introduced into the mixer in the amount specified by the job mix formula.
- B. After the required amounts of aggregate and asphalt concrete material have been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles is secured.
- C. The asphalt concrete material and aggregate for pugmill mixtures shall be introduced into the mixer within 35°F of each other. Temperature of pugmill mixtures shall be controlled between 225 and 300°F.
- D. Material delivered to the paver shall not be less than 225°F.

3.05 SPREADING AND FINISHING MIX

- A. The mixture shall be laid upon an approved surface, spread and struck off to the grade and elevation established. Use asphalt concrete pavers to distribute the mixture either over the entire width or over such partial width as may be practicable.



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- B. The longitudinal joint in one layer shall offset that in the layer immediately below by approximately 6 inches.
- C. Where paving operations are on the present traveled roadway, and where the thickness of pavement course being placed is greater than 1 inch, the Contractor shall arrange his paving operations so that there will be no exposed longitudinal joint between adjacent travel lanes at the end of a day's run.
- D. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked, and luted by hand tools. For such areas the mixture shall be dumped, spread, and screeded to give the required compacted thickness.
- E. Transport and place asphalt concrete mixture on the roadway in a manner that will minimize segregation. Remove segregated areas behind the paver immediately and replace the segregated material with specification material before the initial rolling has taken place. The removal and replacement of nonspecification material or unacceptable work shall be accomplished at no additional expense to the Contractor.
- F. Place asphalt concrete material as continuously as possible. Rollers shall not pass over the unprotected end of a freshly laid mixture unless authorized by the Owner. Form transverse joints by cutting back on the previous run to expose the full depth of the course. When directed, use a coat of asphalt concrete tack/primer emulsion coating on contact surfaces of all joints just before additional mixture is placed against the previously rolled material.

3.06 COMPACTING MIX

- A. After the asphalt concrete mixture has been spread and struck off, and surface irregularities have been adjusted, thoroughly and uniformly compact mixture by rolling.
- B. Roll surface when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking, or shoving.
- C. The number, weight, and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition.
- D. Begin rolling at the sides and proceed longitudinally parallel to the road centerline, each trip overlapping one half the roller width, gradually progressing to the crown of the road. When paving in echelon or abutting a previously placed lens, roll the longitudinal joint first, then follow regular rolling procedure. On superelevated curves, begin rolling at the low side and progress to the high side by overlapping of longitudinal trips parallel to the centerline.
- E. Continue rolling until all roller marks are eliminated and the minimum density specified has been obtained.



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- F. Any displacement occurring as a result of the reversing of the direction of a roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the asphalt concrete mixture.
- G. To prevent adhesion of the mixture to the rollers, keep wheels properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted.
- H. Along forms, curbs, headers, walls, and other places not accessible to the rollers, thoroughly compact mixture with herd tampers or with mechanical tampers.
- I. Remove mixture that becomes loose and broken, mixed with dirt, or is in any way defective, and replace with fresh hot mixture; compact to conform with the surrounding area.

3.07 ACCEPTANCE REQUIREMENTS

- A. Surface Tolerance: The variation between any two contacts with the surface shall not exceed 1 inch vertical in a 10 foot length. Correct all humps or depressions exceeding the specified tolerance by removing defective work and replacing it with new material at no additional expense to the Owner.
- B. Density: Acceptable density of the in place asphalt concrete pavement shall be 95 percent of the optimum values as determined from the job mix formula. Field sampling and density determinations shall be made in accordance with AASHTO T230 68, or an acceptable nuclear procedure.
- C. A uniform compacted thickness shall be obtained for each course equal to or greater than the design thickness shown. Individual tests shall not vary by more than plus or minus ¼ inch.
- D. Mix Tolerances: The following tolerances for the job mix formula will be allowed per single test:

Sieve Designation	Percent Passing
No. 8 and larger sieves	+ 8
Smaller than No. 8 to larger than No. 200 sieve	+ 6
No. 200 sieve	+ 3
Asphalt content, weight percent total mix	+ 0.5



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3.08 FIELD QUALITY CONTROL

A. Placement

1. Place the mixture on the roads, pavements, or walks at a temperature not less than 225°F.

B. Tests

1. The type and size of the samples shall be suitable to determine conformance with stability, density, thickness, and other specified requirements. Use an approved power saw or core drill for cutting samples. Furnish all tools, labor, and materials for cutting samples, testing, and replacing the pavement where samples were removed. Take a minimum 1 sample per 200 tons of asphalt concrete placed.

C. Acceptance Criteria

1. General: Acceptance will be based on the following characteristics of the bituminous mixture and completed pavement as well as the implementation of the Contractor's Quality Control plan and test results:
  - a. Stability
  - b. Flow
  - c. Air Voids
  - d. Mat Density
  - e. Joint Density
  - f. Thickness
2. Smoothness
3. Grade
4. Aggregate Gradation

END OF SECTION



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SECTION 32 13 13 - SITEWORK CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Provisions of Division 01 apply to this section
- B. Section Includes:
  - 1. Cast-in-place concrete pavement placement and finishing.
- C. Related Sections:
  - 1. Section 31 23 00 – Earthwork
  - 2. Section 32 11 23 – Aggregate Base Course

1.2 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings indicating locations of cast-in-place concrete Work and accessory items such as inserts, anchors and vapor barriers. Include details and locations of reinforcing, embedded items, and interfacing with other Work.
- B. Product Data:
  - 1. Mix Design: Submit a concrete mix design for each mix that will be provided for the Work. Include water/cement ratio, size of coarse aggregate, amount of any admixtures, minimum compressive strength, maximum slump and air content percentage.
  - 2. Manufacturer of ready-mixed concrete shall deliver to the owner's representative a certificate with each mixer truck. Certificate shall bear the signature of representative of the testing laboratory, and shall state quantity of cement, water, fine and coarse aggregate and admixtures.
- C. Samples and mock ups:
  - 1. Samples: Submit for approval one sample of each paving color and finish illustrating concrete colors and finishes, minimum 12 inches x 12 inches in size.
  - 2. Mock ups: Construct one 4' x 4' minimum sample of each color, finish and joint type for approval on site. If approved, sample may be retained as final construction.
- D. Certificates: Submit a notarized certificate that each of following conforms to standards indicated:
  - 1. Aggregates – ASTM Standards C33
  - 2. Admixtures - ASTM Standards C260
  - 3. Curing materials – ASTM Standards C171

1.3 QUALITY ASSURANCE

- A. Comply with the following as a minimum requirement:



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American Concrete Institute (ACI) Publication:

ACI 211 - Recommended Practice for Selecting Proportions of Concrete.

ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

ACI 305 - Recommended Practice for Hot Weather Concreting.

ACI 306 - Recommended Practice for Cold Weather Concreting.

ACI 308 - Recommended Practice for Curing Concrete.

ACI 309 - Recommended Practice for Consolidation of Concrete.

American Society for Testing and Materials (ASTM) Standards:

ASTM A 185 - Welded Steel Wire Fabric For Concrete Reinforcement.

ASTM C 31 - Making and Curing Concrete Test Specimens in the Field.

ASTM C 33 - Concrete Aggregates.

ASTM C 39 - Compressive Strength of Cylindrical Concrete Specimens.

ASTM C 88 - Soundness of Aggregates by use of Sulphate or Magnesium Sulphate.

ASTM C 94 - Ready-Mixed Concrete.

ASTM C 143 - Slump of Hydraulic Cement Concrete.

ASTM C 150 - Portland Cement.

ASTM C 171 - Sheet Materials for Curing Concrete.

ASTM C 172 - Sampling Freshly Mixed Concrete.

ASTM C 173 - Air Content of Freshly Mixed Concrete by the Volumetric Method.

ASTM C 227 - Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).

ASTM C 231 - Air Content of Freshly Mixed Concrete by the Pressure Method.

ASTM C 260 - Air-Entraining Admixtures for Concrete.

ASTM C 289 - Potential Reactivity of Aggregates (Chemical Method).

ASTM C 494 – Chemical Admixtures for Concrete

- B. ASTM D 1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).



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- C. Strength Test of Concrete: Refer to Testing and Inspection within the General Provisions sections.

1.4 TOLERANCES FOR CONCRETE PAVING

- A. General: Variations below list the maximum permissible deviations from established lines, grades and dimensions for all exposed concrete.
- B. Variation from Plumb:
1. In the lines and surfaces of pavements: In 10 feet, maximum 1/4 inch
  2. For control-joint grooves and other conspicuous lines:
    - a. In any 20 feet, maximum 1/4 inch
    - b. In any 40 feet or more, 1/2 inch
- C. Variation from the Level or from the Grades shown per Civil Engineer Drawings:
1. In pavements:  
In any 10 feet, 1/4 inch  
In 20 feet, maximum 3/8 inch  
In 40 feet or more, 3/4 inch
  2. For exposed joints and other conspicuous lines:  
In any 20 feet, maximum 1/4 inch  
In 40 feet or more, 1/2 inch
- D. Variation in the Sizes and Locations of Sleeves and Wall Openings: Plus or minus 1/4 inch.
- E. Variation in Cross-Sectional Thickness of Slabs:
1. Minus 1/4 inch
  2. Plus 1/2 inch
- F. Variation in Radii:
1. In radii of less than 10 feet:  
In any 5 feet, 1/8 inch  
In any 10 feet, 1/4 inch  
In radii of 20 feet:  
In any 10 feet, 1/4 inch  
In any 20 feet, 3/8 inch  
In radii of 30 feet or more:  
In any 20 feet, 1/2 inch  
In any 30 feet, 1 inch

1.5 Rejected Materials: Remove off the site all concrete below specified strength.

- A. Cost of Removal and Re-testing: Pay for full costs of removal of rejected concrete and its replacement with concrete of specified strength and re-testing.



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1.6 DELIVERY, STORAGE AND HANDLING

- A. Mixing and Placing Concrete: Refer to Section 01: Testing and Inspection.
- B. Ready-mix concrete shall be mixed and delivered in accordance with ASTM C 94 and CBC Standard 19-3 and 19-4. Each batch of concrete delivered to the Project site shall be accompanied by a time slip bearing departure time and signature of batch plant supervisor. Concrete shall be placed within 90 minutes after start of mixing.
  - 1. Store cement and aggregate materials so as to prevent their deterioration or intrusion by foreign matter. Deteriorated or contaminated materials shall not be furnished.

1.7 JOB CONDITIONS

- A. Cold Weather Requirements:
  - 1. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather. Surfaces, in which concrete is to come in contact with, shall be free from frost or ice. No frozen materials or materials containing ice shall be furnished.
  - 2. When placing concrete during freezing or near-freezing weather the mix shall have a temperature of at least 50 degrees F., but not more than 90 degrees F. when cement is added. Concrete shall be maintained at a temperature of at least 50 degrees F. for at least 72 hours after placing or until it has thoroughly hydrated. When necessary, concrete materials shall be heated before mixing. Special precautions shall be provided for protection of transit-mixed concrete.
- B. Hot Weather Requirements:
  - 1. During hot weather, proper attention shall be provided for ingredients, production methods, handling, placing, protection and curing, to prevent excessive concrete temperatures or water evaporation which could impair required strength or durability.
- C. Protection: Protect the sidewalks against all damage prior to final acceptance of the work. Exclude traffic from the sidewalks by erecting and maintaining barricades and signs until the concrete is at least fourteen (14) days old, or for a longer period if so requested by Owner's Representative.
- D. Provide written confirmation from Contractor's surveyor that subgrade is consistent with drawings and from Owner's soils inspector that subgrade is firm to receive concrete work prior to pouring walks.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Ready-Mixed Concrete: Mix and deliver in accordance with requirements of CBC Chapter 1905A.



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- B. Strength of Concrete: Concrete, unless otherwise indicated or specified, shall be provided with a minimum ultimate 28-day strength of 2500 psi (f'c). For high-early-strength concrete, age for reaching the f'c shall be as indicated on Drawings.

## 2.2 MATERIALS

- A. CEMENT ASTM C150, Type II or Type V Portland Cement as conforming to ASTM C150 and the latest geotechnical soils report. Cement shall be from a single source for the entire project.
- B. Aggregates: Aggregates shall conform to ASTM C 33 and C 227 except as modified herein. Any suitable individual grading of coarse aggregate may be furnished, provided Grading of Combined Aggregate indicated in following table is obtained. Refer to Section 01420: Testing and Inspection.
- C. Water: Water shall be potable and free from deleterious matter.
- D. Admixtures: CBC Chapter 19A, Section 1903A.6, Type A or D.
- E. Pedestrian Concrete Expansion Joint: Asphalt coated fiber expansion joint material.
- F. Vehicular/Wall Concrete Expansion Joint: Asphalt coated fiber expansion joint material.
- G. Horizontal Flatwork Joint Sealant: Two-part, Type 1 sealant, gun-grade, polyurethane with a Shore 'A' hardness of not less than 40 after 72 hours. Custom sealant colors to match adjacent concrete finishes as approved by the Architect.
- H. Vertical Wall Joint Sealant: Three-part, Type 1 sealant, gun-grade, polyurethane with a Shore 'A' hardness of not less than 40 after 72 hours. Custom sealant colors to match adjacent concrete finishes as approved by the Architect or Owner's Representative.
- I. Bond breaker tape to be as recommended by sealant manufacturer.
- J. Color: To be specified by Architect.
- K. Liquid Curing Compounds: A standard brand, clear liquid conforming to ASTM C 309, Master Builders, Grace, Antihydro or equal.
- L. Abrasive Aggregate: Norton Alundum, Union Carbide Carborundum, or equal, graded #12 through #30 sizes, color as selected by Architect.
- M. Underlayment: Latex underlayment for filling low spots in concrete shall be Tile-Tex by Flintkote Co., Webtex #60 or Fixallatex by Dowman Products Co or equal.

## 2.3 WOOD FORMS

- A. Wood For Concrete Flatwork:



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1. Exposed Concrete Surfaces: Plywood, PSI; B face on contact side, Ext. Grade, Douglas Fir, Class I; not less than 5/8 inch thick. Mill oil or resin coat both surfaces at factory and seal edges; use type that will not stain or leave residue on concrete.
2. Mill top edges of all wood form work for integral color concrete work to achieve 90 degree radius edges.
3. Unexposed Concrete Surfaces: Board forms or plywood as specified for exposed concrete surfaces. Board forms; #2 Douglas Fir, sound, good quality, and free from loose knots; not less than 3/4 inch thick.

2.4 FORM OIL

- A. Non staining mineral oil type.

2.5 FORM COATING

- A. Euclid Chemical Co.'s Eucoslip, W.R. Grace's Formfilm, Noxcrete's Pre-Form, or approved equal.

2.6 SAWCUT BLADES

- A. Saw BladeType: 3/16" Width for 3" handsaw.

PART 3 - EXECUTION

3.1 GENERAL

- A. Time of Placing: Do not place concrete until reinforcement, conduits, outlet boxes, anchors, hangers, sleeves, bolts, and other embedded materials are securely fastened in place. Contact the OWNER'S REPRESENTATIVE at least 24 hours before placing concrete; do not place concrete until inspected by the OWNER'S REPRESENTATIVE.
- B. Pouring Record: A record shall be kept on the Project site of time and date of placing concrete in each portion of structure. Such record shall be maintained on the Project site until Substantial Completion and shall be available for examination by the Architect..

3.2 PREPARATION

- A. Moisture Barrier: Before installation of screeds and slab reinforcement, install a moisture barrier under slabs on grade. Place membrane in as large sheets as possible, lapped 12 inches at sides and ends, with top lap placed in the direction of the spreading of concrete. Extend membrane and lap at least 4 inches onto adjoining wall surfaces and seal with pressure-sensitive tape.
  1. Install moisture barrier on minimum 2-inch bed of sand, unless otherwise indicated, over gravel base as indicated on the Drawings.



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2. Patch punctures and tears in moisture barrier.

- B. Anchor Slots: Dove-tail anchor slots at concrete walls to receive masonry veneer shall be set vertically in forms, 24 inches maximum on centers measured horizontally. Anchor slots shall be No. 24 gage galvanized sheet steel with removable fiber filler to prevent seepage of cement in slot.
- C. Screeds: Install screeds accurately and maintain at required grade or slab elevations after steel reinforcement has been installed , but before starting to place concrete. Install screeds adjacent to walls and in parallel rows not to exceed 8 feet on centers.

### 3.3 INSTALLATION

- A. Surface Drainage:
1. Provide for positive drainage on all concrete paving surfaces.
  2. Report in writing any discrepancies or omissions on drawings and conditions on the site which would prevent proper drainage.
  3. No "birdbaths" or other surface irregularities will be permitted. Properly correct irregularities.
- B. Securement: Use templates for all anchor plates, bolts, inserts and other items embedded in concrete. Accurately secure so that they will not be displaced during placing of concrete.
- C. Electrical Conduit: Do not embed piping, other than electrical conduit, in structural concrete. Locate conduit to maintain strength of structures at maximum as directed by the Structural Engineer. Verify size, length and location of electrical conduit.
- D. Conveying and Placing:
1. Concrete shall be placed only under direct observation of the OWNER'S REPRESENTATIVE. Do not place concrete outside of regular working hours, unless the OWNER'S REPRESENTATIVE has been notified at least 48 hours in advance.
  2. Concrete mixing shall continue until concrete is completely discharged. Minimum of mixing time shall be 3 minutes at the job site.
  3. Under no circumstances shall the Contractor add water to the concrete mix.
  4. Concrete shall be conveyed from mixer to location of final placement by methods, which will prevent separation or loss of materials.
  5. Concrete shall be placed as nearly as practicable to its final position to avoid segregation due to re-handling or flowing. No concrete that has partially hydrated or has been contaminated by foreign materials shall be placed, nor shall re-tempered concrete or concrete which has been remixed after initial set be placed.
  6. In placing concrete in columns, walls or thin sections, provide openings in forms, elephant trunks, tremies or other recognized devices, to prevent segregation and accumulation of partially hydrated concrete on forms or metal reinforcement above level of concrete being placed. Such devices shall be installed so that



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concrete will be dropped vertically. Unconfined vertical drop of concrete from end of such devices to final placement surface shall not exceed 6 feet.

7. Concrete shall be placed as a continuous operation until placing of panel or section is completed. Top surfaces of vertically formed lifts shall be level.
8. Place alternate pours of concrete within 24 hours of one another, preferably the same day, to eliminate color variations due to curing.
9. Concrete shall be thoroughly consolidated during placement, and shall be worked around reinforcement and embedded fixtures with mechanical vibrators.
10. Where conditions make consolidation difficult, or where reinforcement is congested, batches of mortar containing same proportions of cement, sand, and water as provided in the concrete, shall first be deposited in the forms to a depth of at least one inch.

### 3.4 FORMWORK

#### A. General:

1. Construct forms accurately to dimensions, plumb and true to line and grade. Use forms that are substantial, mortar tight, braced and tied so as to maintain position and shape during placing of reinforcing and concrete.
2. Wavy surfaces and bulged slab surfaces resulting from settlement or springing of formwork will be rejected.
3. Carefully verify and check all forms for alignment and level as the work proceeds. Promptly make all needed adjustments or additional bracing.
4. Pre-saturation of Subgrade: The Contractor shall pre-saturate the subgrade of all concrete flatwork prior to sand base and concrete placement as required by the Geotechnical Soils Engineer.

### 3.5 CONSTRUCTION JOINTS

- A. Construct and assemble forms in such a manner that joints occur at accepted locations. Thoroughly clean forms before placing concrete.
- B. Details: Take extreme care in all details of forming, setting and reinforcing. Except where tooled corners are indicated, provide all exposed concrete finish work with smooth, even surfaces of dense concrete with clean sharp arises and outside corners.
- C. Coordination: After forms have been placed and accepted, ensure that all other trades have been properly notified and are given sufficient time to complete installation of their work.
- D. Recesses and Openings: Provide as shown on the Drawings or as may be directed at the site.
- E. Responsibility: Each trade shall be entirely responsible for proper installation and securing of the work during placing of concrete.
- F. Prior to Placing Concrete:
  1. Thoroughly clean out all forms to be used.



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2. Thoroughly wet wood forms as required where form coatings are not used.

G. Removal of Forms:

1. Do not remove supporting forms or shoring until concrete has sufficient strength to carry its own weight and other loads upon it.
2. Remove forms only after concrete has properly set and without damaging concrete.

H. Compaction and Screeding:

1. Tamp freshly placed concrete with a heavy tamper until at least 3/8 inch of mortar is brought to surface. Concrete shall then be tamped with a light tamper and screeded with a heavy straightedge until depressions and irregularities are eliminated, and surface is true to finish grades or elevations. Remove excess water and debris.
2. Where slabs are to receive separate cement finish or mortar setting bed, continued tamping to raise mortar to surface is not performed. Laitance shall be removed by brushing with a stiff brush or by light sandblasting to expose clean top surface of coarse aggregate.

I. Floating and Troweling:

1. When concrete has hydrated sufficiently, it shall be floated to a compact and smooth surface. After floating, wait until concrete has reached proper consistency before troweling. Top surfaces shall receive at least 2 troweling operations with steel hand trowel. Prior to and during final troweling, apply a fine mist of water frequently with an atomizing type fog sprayer. Omit troweling for slabs to receive a separate cement finish.
2. Exterior Paving and Cement Walks: Finish as specified above, except surface shall be given a non-slip finish to match Sample reviewed by the Architect.
3. Vertical concrete surfaces shall be finished smooth and free from marks or other surface defects.

3.6 SAWCUT JOINTS

- A. Install sawcut control joints and sawcut expansion joints using acceptable mechanical concrete saw with a new diamond-tipped blade as soon as concrete surface is sufficiently firm not to be torn, damaged by the blade, or cause spalling of the finish. Install sawcut control joints within 48 hours from time of placement.
- B. Cut all sawcut joints to a uniform depth and width as called out on the Drawings. All joints shall be clean, smooth, and straight. Use forms or templates as required to achieve a consistent plumb and straight quality. Joints shall end cleanly at edge of slab and shall not extend into adjacent concrete pours.
- C. A small radius blade (hand saw) shall be used to extend depth of cut to bring sawcut joints to within 1/2" of vertical surfaces and connect to perpendicular sawcut joints. Overlapping of sawcut joints into adjacent concrete panels or bands or wavy joint lines are not acceptable and will be rejected. Mis-jointed panels will be rejected.



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3.7 Curing:

- A. Concrete shall be maintained above 50 degrees F., and in a moist condition for 7 days after placing, except that high early strength concrete shall be maintained in a moist condition for 3 days.
- B. Forms containing concrete, top of concrete between forms, and exposed concrete surfaces after removal of forms shall be maintained in a thoroughly wet condition for at least 7 consecutive days after placing.
- C. If weather is hot or surface has dried out, spray surface of concrete slabs and paving with fine mist of water, starting not later than 2 hours after final troweling and continuing until sunset. Surface of finish shall be kept continuously wet until curing medium has been installed.
- D. Within 24 hours after finishing, exterior slabs may be cured with clear liquid curing compound immediately installed in accordance with manufacturer's directions. Perform all sawcuts within 24 hours after pouring.

3.8 FINISHING

- A. Portland cement concrete paving shall have a medium salt (medium broom) finish on all surfaces with less than 6% slope and slip resistant (heavy broom finish) on all surfaces with slopes 6% or greater.

3.9 EXPANSION AND CONSTRUCTION JOINTS

- A. General: Place and finish joins for sidewalks per Section 303-5.4 of the Standard Specifications for Public Works Construction, and as approved by Owner's representative.
- B. Construction Joints: Details and proposed location of construction joints shall be as indicated on the Drawings, located to least impair strength of structure, in accordance with the following:
  - 1. Thoroughly clean contact surface by sand blasting entire surface not earlier than 5 days after initial placement.
  - 2. A mix containing same proportion of sand and cement provided in concrete plus a maximum of 50 percent of coarse aggregate shall be placed to a depth of at least one inch on horizontal joints. Vertical joints shall be wetted and coated with a neat cement grout immediately before placing of new concrete.
  - 3. Should contact surface become coated with earth, sawdust, or deleterious material of any kind after being cleaned, entire surface shall be re-cleaned before applying mix.
- C. Expansion Joints: Placement: Place joint materials with top edge of 1/4-inch wide fiber expansion joint filler approximately 1/2 inch below the paved surface. Securely hold in place with adhesive to prevent movement during second pour.



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1. Forming: Form joints and other edges in the fresh concrete using an edging tool to provide a smooth uniform impression for sawcutting. Strike all edges before and after brooming.
2. Joint Material: Asphalt coated fiber expansion joint material required. Do not use foam fillers.

D. Sawcut: Sawcut with 3/16-inch wide sawblades.

E. Tooled Joints: Slabs, walks and paving shall be marked into areas as indicated with markings made with a V-grooving tool. Marks shall be round-edged, free from burrs or obstructions, with clean cut angles and shall be straight and true. Walks, if not indicated, shall be marked off into rectangles of not more than 12 square feet and shall have a center marking where more than 5 feet wide.

### 3.10 TESTING

A. Molded Cylinder Tests:

1. Owner's Consultant will prepare cylinders. Each cylinder shall be dated, given a number, point in structure from which sample was obtained, mix design number, mix design strength and result of accompanying slump test noted.
2. Separate tests of molded concrete cylinders obtained at same place and time shall be made at age of 3 days, 7 days, and 28 days. A strength test shall be the average of the compressive strength of 2 cylinders, obtained from the same sample of concrete and tested at 28 days or at test age designated for determination of f'c.
3. Test cylinders shall be prepared at the Project site and stored in testing laboratory in accordance with ASTM C 31, and tested in accordance with ASTM C 39.

B. Core Test: At request of the Architect, cores of hardened concrete shall be cut from portions of hydrated structures for testing, in accordance with CBC and ASTM C 42.

1. Provide 4 inch diameter cores at representative places throughout the structure as designated by the Architect.
2. In general, provide sufficient cores to represent concrete placed with at least one core for each 4,000 square feet of building area, and at least 3 cores total for each Project.
3. Where cores have been removed, fill voids with drypack, and patch the finish to match the adjacent existing surfaces.

C. Concrete Consistency: Measure consistency according to ASTM C 143. Test twice each day or partial day's run of the mixer.



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- D. Adjustment of Mix: If the strength of any grade of concrete for any portion of Work, as indicated by molded test cylinders, fall below minimum 28 days compressive strength specified or indicated, adjust mix design for remaining portion of construction so that resulting concrete meets minimum strength requirements.
- E. Filling, Leveling and Patching:
1. Voids: Fill holes with a 1:3 cement and sand mortar with the same color as the adjoining concrete. Mix and place the mortar as dry as possible and finish flush with the adjacent surface..
  2. Holes resulting from form ties or sleeve nuts shall be solidly packed, through exterior walls, by pressure grouting with cement grout, as specified. Grouted holes on exposed surfaces shall be screeded flush and finished to match adjoining surfaces.
  3. Corrective patching: Correct all defects in concrete work. Chip all voids to a depth of at least 1 inch with the edges perpendicular to the surface and parallel to form markings. Fill all voids, surface irregularities, by patching or rubbing. Ensure that all concrete surfaces so repaired duplicate the appearance of the unpatched work.
  4. Cleaning: Four weeks after installation, wash the exposed concrete finishes with a mild acid solution to remove any free-lime efflorescence on the concrete surface, pressure wash and/or hand scrub the concrete finishes to thoroughly clean the concrete surfaces prior to preliminary review by the architect.
- F. Defective Concrete:
1. Should strength of any grade of concrete, for any portion of Work indicated by tests of molded cylinders and core tests, fall below minimum 28 days strength specified or indicated, concrete will be deemed defective Work and shall be replaced or adequately strengthened in a manner acceptable to the Architect..
  2. Concrete Work that is not formed as indicated, is not true within 1/250 of span, not true to intended alignment, not plumb or level where so intended, not true to intended grades and levels, contains sawdust shavings, wood or embedded debris, or does not fully conform to Contract provisions, shall be deemed to be defective Work and shall be removed and replaced.
- G. Concrete For Equipment Pads, Mechanical and Electrical Work: Unless otherwise indicated, strength shall be 3,000 psi concrete. Exposed concrete shall be provided with a hand trowel finish with radius corners and edges. Form and place concrete where necessary as described in Section 031000: Concrete Formwork and Accessories, and reinforced as described in Section 032000: Concrete Reinforcement. Calcium chloride shall not be furnished in any concrete mix provided for the installation of underground electrical conduits. For concrete encasement of more than one conduit, furnish 3/4 inch to 1 inch aggregate as specified for concrete mix.

3.11 CLEAN UP

- A. Remove rubbish, debris and waste materials immediately and legally dispose of off the Project site.



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3.12 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION



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SECTION 32 17 13 - PARKING BUMPERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Precast concrete wheel stops.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 PARKING BUMPERS

- A. Precast Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete; 4000-psi minimum compressive strength. Provide chamfered corners and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.
  - 1. Source Limitations: Obtain wheel stops from single source from single manufacturer.
  - 2. Surface Appearance: Smooth, free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that pavement is in suitable condition to begin installation in accordance with manufacturer's written instructions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install wheel stops in accordance with manufacturer's written instructions unless otherwise indicated.
- B. Securely anchor wheel stops to substrate with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

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SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Painted markings applied to asphalt paving.
  - 2. Painted markings applied to concrete surfaces.
- B. Related Sections:
  - 1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

- A. Product Data: Include technical data and tested physical and performance properties.
  - 1. Pavement-marking paint, acrylic.
  - 2. Glass beads.
- B. Shop Drawings:
  - 1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
  - 2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- C. Samples: For each exposed product and for each color and texture specified; on rigid backing, 8 inches square.

1.03 INFORMATIONAL SUBMITTALS

- A. Sustainable Design Submittals:
  - 1. Documentation for paints and coatings, indicating VOC content.

1.04 FIELD CONDITIONS

- A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.



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PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Columbia Paint & Coatings, Inc.; a subsidiary of Sherwin-Williams Company (The).
  2. Diamond Vogel Paint Company.
  3. Insl-X Products; Benjamin Moore & Co.
  4. PPG Paints; PPG Industries, Inc.
  5. Rust-Oleum Corporation; a subsidiary of RPM International, Inc.
  6. Transpo Industries, Inc.
- B. Source Limitations: Obtain pavement-marking paints from single source from single manufacturer.

2.02 SUSTAINABLE DESIGN CRITERIA

- A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
1. Paints and Coatings:
    - a. VOC content limits for field applications.

2.03 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and California Building Code, Chapter 11.

2.04 PAVEMENT-MARKING PAINT

- A. Pavement-Marking Paint, Acrylic: Acrylic, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952F, Type II, with drying time of less than 45 minutes.
1. Color: As indicated.
- B. Glass Beads: AASHTO M 247, Type 1 or FS TT-B-1325D, Type 1.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that pavement-marking substrate is dry and in suitable condition to begin pavement marking in accordance with manufacturer's written instructions.

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- B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.02 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow asphalt paving or concrete surfaces to age for a minimum of 30 days before starting pavement marking, but not less than recommended by paint manufacturer.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
  - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to asphalt paving or concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
  - 2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal..

3.03 PROTECTING AND CLEANING

- A. Protect pavement markings from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION



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SECTION 32 17 26 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Detectable warning unit pavers.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For each type of exposed finish requiring color selection.

1.03 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

1.04 PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- B. Weather Limitations for Mortar and Grout:
  - 1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
  - 2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.
    - a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set unit pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.01 TACTILE WARNING SURFACING, GENERAL

- A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and California Building Code, Chapter 11 for tactile warning surfaces.

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1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

- B. Source Limitations: Obtain each type of tactile warning surfacing, joint material , and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

## 2.02 DETECTABLE WARNING UNIT PAVERS

- A. Detectable Warning Concrete Unit Pavers: Solid paving units, made from normal-weight concrete with a compressive strength of not less than 5000 psi, water absorption of not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67, with accessible detectable warning truncated domes on exposed surface of units.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Advanced Surfaces Inc.
  - b. Armor-Tile.
  - c. ECG, Inc.; a division of Elizabeth City Glass Co.
  - d. Hanover Architectural Products.
  - e. Tile Tech Pavers.
2. Shapes and Sizes: As indicated on Drawings
3. Dome Spacing and Configuration: As indicated on Drawings.
4. Color: As indicated on Drawings.

- B. Mortar Setting Bed:

1. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.
2. Thinset Mortar: Latex-modified portland cement mortar complying with ANSI A118.4.
3. Water: Potable.

## 2.03 ACCESSORIES

- A. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.



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PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF TACTILE WARNING SURFACING

- A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

3.03 INSTALLATION OF DETECTABLE WARNING UNIT PAVERS

- A. Unit Paver Installation, General:
  - 1. Mix unit pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
  - 2. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.
  - 3. Tolerances: Do not exceed 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- B. Mortar Setting-Bed Applications:
  - 1. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
  - 2. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch thickness for bond coat.
  - 3. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
  - 4. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
  - 5. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch- thick bond coat to mortar bed or to back of each paver with a flat trowel.
  - 6. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

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7. Grouted Joints: Grout paver joints complying with ANSI A108.10. Grout joints as soon as possible after initial set of setting bed.
  - a. Force grout into joints, taking care not to smear grout on adjoining surfaces.
  - b. Tool exposed joints slightly concave when thumbprint hard.
  - c. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.
8. Remove excess grout from exposed paver surfaces; wash and scrub clean.
9. Protect installation from traffic until grout has set.

3.04 CLEANING AND PROTECTION

- A. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.
- B. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION



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SECTION 32 31 19 - DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Horizontal-slide gates.
  - 2. Gate operators, including controls.
- B. Related Sections:
  - 1. Section 08 71 00 "Door Hardware" for gate hardware not specified in this Section.
  - 2. Division 26 Sections for electrical service and connections for system disconnect switches and powered devices including, but not limited to, motor operators, controls, and limit switches.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For fencing and gates.
  - 1. Include plans, elevations, sections, gate locations, post spacing, and attachment details, and grounding details.
  - 2. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
  - 3. Wiring Diagrams: Include diagrams for power, signal, and control wiring.
- C. Samples: For each fence material and for each color specified.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:
  - 1. Ametco Manufacturing Corp.
  - 2. A&T Iron Works, Inc.
  - 3. Fortress Building Products.
  - 4. Omega II Fence Systems.

2.02 PERFORMANCE REQUIREMENTS

- A. Wind Loading:
  - 1. Fence Height: As indicated on Drawings.

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2. Wind Exposure Category: As indicated on Drawings.
3. Design Wind Speed: As indicated on Drawings.

2.03 HORIZONTAL-SLIDE GATES

- A. Basis-of-Design Product: Ameristar Perimeter Security USA, Inc.; PassPort Commercial; Style: Majestic.
- B. Gate Configuration: As indicated.
  1. Type: Rolling gate, with on-grade track.
- C. Gate Frame Height: As indicated.
- D. Gate Opening Width: As indicated.
- E. Galvanized-Steel Frames and Bracing: Fabricate members from square tubing.
- F. Additional Rails: Provide as indicated, complying with requirements for fence rails.
- G. Infill: Comply with requirements for adjacent fence.
- H. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.
- I. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.
- J. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A123/A123M. For hardware items, hot-dip galvanize to comply with ASTM A153/A153M.
- K. Metallic-Coated-Steel Finish: High-performance coating.

2.04 GATE OPERATORS

- A. Gate Operators:
  1. Basis-of-Design Product: Subject to compliance with requirements, provide HySecurity (Nice North America LLC); SlideDriver, or comparable product by approved manufacturer.
- B. Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.
  1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.

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2. Provide operator with UL approval.
  3. Provide electronic components with built-in troubleshooting diagnostic feature.
  4. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.
- C. Comply with NFPA 70.
- D. UL Standard: Manufacturer and label gate operators to comply with UL 325.
- E. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:
1. Enclosure: Totally enclosed.
  2. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
  3. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
- F. Gate Operators:
1. Mechanical Slide Gate Operators:
    - a. Duty: Heavy duty, commercial/industrial.
- G. Controls: As selected by Architect from manufacturer's full range.
- H. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.
- 2.05 STEEL AND IRON
- A. Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.
- C. Tubing: ASTM A500/A500M, cold-formed steel tubing.
- D. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, Grade 50, with G90 coating.
- 2.06 MISCELLANEOUS MATERIALS
- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

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- B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 03 30 00 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C387/C387M mixed with potable water according to manufacturer's written instructions.
- C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M and specifically recommended by manufacturer for exterior applications.

2.07 METALLIC-COATED-STEEL FINISHES

- A. Galvanized Finish: Clean welds, mechanical connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.
- B. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.
- C. Powder Coating: Immediately after cleaning and pretreating, apply manufacturer's standard TGIC polyester powder-coat finish to a minimum dry film thickness of 2 mils.
  - 1. Color and Gloss: Black.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

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DECORATIVE METAL FENCES AND  
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3.03 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.04 GATE OPERATOR INSTALLATION

- A. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
- B. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.05 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware, gate operators, and other moving parts.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION

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SECTION 32 84 00 – PLANTING IRRIGATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Section includes automatic-control irrigation system as shown on the Drawings and as follows:
  - 1. Trenching
  - 2. Piping and Fitting
  - 3. Valving
  - 4. Assemblies
  - 5. Automatic Controllers
  - 6. Specialties
  - 7. Wiring
  - 8. Sprinklers
  - 9. Cleanup
  - 10. Connections to existing mains or municipal water systems.
- B. Related work:
  - 1. Section 32 01 90: Landscape Maintenance and Operations of Site Improvements
  - 2. Section 32 91 13: Soil Preparation
  - 3. Section 32 90 00: Landscape Planting
- C. Definition: The word Architect as used herein shall refer to the Landscape Architect or the Owner's authorized representative.

1.2 QUALITY ASSURANCE AND REQUIREMENTS

- A. Permits and Fees: The Contractor shall obtain and pay for any normally required and permits, fees and inspections as required.
- B. Manufacturer's Directions: Manufacturer's directions and detailed Drawings shall be followed in cases where the manufacturers of articles used in this contract furnish directions covering points not shown in the Drawings and Specifications.
- C. Ordinances and Regulations: Any local, municipal and state laws, and rules and regulations governing or relating to any portion of this work, are hereby incorporated into and made a part of these Specifications and their provisions shall be carried out by the Contractor. Anything contained in these Specifications shall not be construed to conflict with any of the above rules and regulations or requirements of the same. However, when these Specifications and Drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these Specifications and Drawings shall take precedence.



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1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.

### 1.3 SUBMITTALS

#### A. Material List

1. Furnish the articles, equipment, materials, or processes specified by name in the Drawings and Specifications per requirements of Division 1 or the General Provisions. No substitutions will be allowed without prior written approval by the Architect.
2. Submit a complete materials list to Architect prior to performing any work. Material list shall include the manufacturer, model number and description of all materials and equipment to be used according to example as follows:

ITEM	DESCRIPTION	MANUFACTURER	MODEL NO.
1	Backflow Preventer		
2	Controller		
3	Isolation Valve		
4	Etc.		

3. Irrigation submittals must be specific and complete. All items must be listed and should include solvent and primer, wire, wire connectors, valve boxes, etc. No copies of manufacturer's literature (catalog cuts) are required as submittal information.
4. Equipment or materials installed or furnished without prior approval of the Architect may be rejected and the Contractor required to remove such materials from the site at his own expense.
5. Approval of any item, alternate or substitute indicates only that the product or products apparently meet the requirements of the Drawings and Specifications on the basis of the information or samples submitted.

#### B. Record Drawings

1. Refer to Division 1 or General Provisions.
2. Record Set During the Work: At site, maintain not less than one complete set of Drawings as a Field Record Set. Record by dimensioning from two permanent points of reference, building corners, sidewalk, or road intersections, etc., the location of the following items:



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- a. Connection to existing water lines.
  - b. Connection to existing electrical power.
  - c. Gate valves.
  - d. Routing of sprinkler pressure lines (dimension maximum 100' along routing).
  - e. Sprinkler control valves.
  - f. Routing of control wiring.
  - g. Quick-coupling valves.
  - h. Items specified under Division 1 or as directed by the Architect.
- C. Final Record Drawings:
1. Prior to substantial completion, the Architect will order for the Contractor, at the Contractor's expense, one complete set of reverse-reading, reproducible mylar transparencies.
  2. The Contractor shall transfer recorded changes in the work indicated on the field set to the reproducible set, neatly and clearly, technically correct, and drafted in ink by a skilled draftsman.
  3. On or before the date of the final inspection, the Contractor shall deliver the corrected and completed reproducible plans to the Architect with a transmittal containing the date, project title and number, Contractor's name, address and authorized signature.
  4. Delivery of the reproducible plans will not relieve the Contractor of the responsibility of furnishing required information that may be omitted from the prints.
- D. Controller Charts:
1. Record Drawings shall be approved by the Architect before controller charts are prepared.
  2. Provide one controller chart for each controller supplied. The chart shall show the area controlled by the automatic controller and shall be the maximum size that the controller door will allow.
  3. The chart shall be a reduced drawing of the actual as-built system. However, in the event the controller sequence is not legible when the drawing is reduced, it shall be enlarged to a size that will be readable when reduced.
  4. The chart shall be a blackline or blueline ozalid print and a different color shall be used to indicate the area of coverage for each station.
  5. When completed and approved, the chart shall be hermetically laminated between two pieces of plastic, each piece being minimum 10 mils thick.
  6. These charts shall be completed and approved prior to final inspection of the irrigation system.
- E. Operation and Maintenance Manuals:
1. Prepare and deliver to Owner within 10 days prior to completion, three hardcover ring binders with the following in each:
    - a. Index
    - b. Guarantee statement.
    - c. Address and phone number of Contractor



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- d. Catalog and parts sheets on every material and equipment installed under this Contract with name, address and phone numbers of manufacturers and local representatives.
  - e. 11" x 17" color copy of controller charts (not laminated).
  - f. Complete operating and maintenance instructions on all major equipment.
- F. In addition to the above-mentioned maintenance manuals, provide the Owner's maintenance personnel with instructions for major equipment and show evidence in writing to the Architect at the conclusion of the project that this service has been rendered.
- G. Extra Equipment to be Furnished:
  - 1. Furnish extra materials described below (match products installed), packaged with protective covering for storage and identified with labels describing contents.
    - a. Special Tools: Two sets of special tools required for removal, disassembling and adjusting each type of sprinkler, drip emitter, and valve on the project.
    - b. Valve Keys: Two five-foot valve keys for operation of gate valves 3" or larger.
    - c. Controller Keys: Two keys for each automatic controller.
    - d. Quick Coupler Keys: Two quick-coupler keys and matching hose swivels for each type of quick coupling valve installed.
    - e. Sprinkler Units: Equal to 10% percent of amount installed for each type and size indicated, but no fewer than 10 units.
    - f. Emitter Units: Equal to 10% percent of amount installed for each type indicated, but no fewer than 10 units.
    - g. Drip Tube Units: Equal to 10 percent of amount installed for each type indicated, but no fewer than 10 units.
  - 2. The above-described equipment shall be turned over to the Owner at the conclusion of the project. Before final inspection can occur, evidence that the Owner has received material must be shown to Architect.

#### 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Handling of PVC Pipe and Fittings: The Contractor is cautioned to exercise care in handling, loading, unloading, and storing of PVC pipe and fittings.
  - 1. All PVC pipe shall be transported in a vehicle which allows the length of pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point.
  - 2. Do not drop PVC pipe on hard surfaces.
  - 3. Any section of pipe that has been dented or damaged is to be discarded.
  - 4. If damaged material is installed, it shall be replaced with new material.



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## 1.5 WARRANTY

- A. Contractor shall fully warrant and agree to replace any poor, inadequate or defective materials and workmanship for one year from date of acceptance of completed Irrigation System. The Architect shall be the sole judge of the acceptability of materials or workmanship.
- B. Replacement: Materials found to be defective, missing or in poor condition during the warranty period shall be replaced immediately. The Architect shall be the sole judge as to the condition of material. Material to be replaced during the warranty period shall be replaced by the Contractor within 15 days of written notification by Owner.

## 1.6 PERFORMANCE REQUIREMENTS

- A. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100% head-to-head coverage in all spray and rotor zones, unless otherwise indicated.
- B. Explanation of Drawings
  - 1. Drawings are diagrammatic and indicative of the work to be installed. All offsets, fittings, sleeves, etc., which may be required, may not be indicated. Carefully investigate the structural and finished conditions affecting all of the work and plan the work accordingly, furnishing such fittings, etc., as may be required to meet such conditions. The work shall be installed in such a manner as to avoid conflicts between irrigation systems, planting, architectural features, drainage systems, or hardscape construction.
  - 2. Do not install the irrigation system as shown on the Drawings when it is obvious in the field that obstructions, grade differences, or discrepancies in area dimensions exist that might not have been considered in the engineering.
    - a. Any discrepancy in Drawings shall be brought to the attention of the Architect. Contractor assumes full responsibility for work installed without clarification.
  - 3. The final location and exact positioning of automatic controllers, backflow prevention assemblies, gate valves, pressure regulators, or other equipment shall be approved by the Owner's authorized representative prior to installation.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Use only new materials of brands and types noted on the Drawings, as specified herein, or approved equivalents.



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## 2.2 PIPE

- A. Pressure supply lines 1 1/2 inches in diameter and smaller downstream of the backflow prevention unit shall be Schedule 40 solvent weld PVC conforming to ASTM D1785.
- B. Pressure supply lines 3 inches in diameter and larger downstream of the backflow unit shall be Class 200 bell and gasket PVC conforming to ASTM 2672.
- C. Non-pressure lines 3/4 inch in diameter and larger downstream of the remote control valve shall be SCH 40 solvent weld PVC conforming to ASTM D1785.
- D. Sleeving shall be SCH 40 solvent weld PVC conforming to ASTM D1785.

## 2.3 POLY VINYL CHLORIDE (PVC) PIPES, TUBES & FITTINGS

- A. PVC pipe, tubes & fittings shall be of the class rating or schedule rating designated on the contract Drawings.
- B. PVC pipe shall continuously bear the following markings:
  - 1. Nominal pipe size.
  - 2. PVC Schedule or class.
  - 3. Type of plastic material in standard code
  - 4. Pressure rating in psi
  - 5. SDR for class rated pipe
  - 6. ASTM designation
  - 7. National Sanitation Foundation (NSF) approval.
  - 8. Manufacturer's name or trademark
  - 9. Date of extrusion.
- C. Schedule rated PVC Pipe shall be made from NSF approved Type 1, Grade I, PVC compound conforming to ASTM D-1785. Schedule rated pipe shall meet requirements as set forth in Federal Specification PS-21-70 (solvent weld pipe).
- D. Class rated PVC Pipe shall be made from NSF approved Type 1, Grade I, PVC compound conforming to ASTM D-2241. Class rated pipe shall meet requirements as set forth in Federal Specification PS-21-70 (solvent weld pipe), with an appropriate Standard Dimension Ratio (SDR).
- E. PVC Fittings, Solvent and Primer:
  - 1. For schedule rated pipe, fittings shall correspond to the same schedule rating.
  - 2. For class rated pipe, fittings shall be Schedule 40.
  - 3. PVC solvent-weld fittings shall be Type 1, Grade I, NSF approved, conforming to ASTM test procedure D-2466.
  - 4. All fittings shall bear the manufacturer's name or trademark, material designation, size, applicable IPS schedule and NSF seal of approval.



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5. Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of the type prescribed by the pipe manufacturer. Installation methods shall be according to ASTM D-2885
- F. Reclaimed Water PVC Pipe and fittings:
  1. All reclaimed water lines shall be purple plastic pipe as required by County Health ordinances, and the Water District.
  2. All above ground reclaimed water fixtures shall have approved identifying labels for reclaimed water, and painted purple, in accordance with County Health ordinances.
- G. Fittings for O-Ring Gasketed Pipe
  1. Fitting shall be ductile iron, slanted, deep bell, gasketed style make in accordance with ASTM A-536, Grade 65-45-12. Fittings shall have four lugs to accommodate joint restraints and other fittings. Bell section shall allow 5-degree freedom of pipe deflection within the bell end. Gasket design shall be re-enforced "U-Cup" configuration to seal and assist in restraining pipe at all pressures. Fittings shall be as manufactured by Leemco, Inc. or approved equal.

## 2.4 VALVES

- A. Ball/Isolation Valves:
  1. Ball valves 2" and smaller:
    - a. Schedule 80 PVC true union ball valves
    - b. 150 PSI at 73°
    - c. Full ported
    - d. Manufacturers: Chemtrol Division of Nibco Inc. model Tru-Bloc, Spears model Multi-Featured Industrial Valve, or equal.
  2. Isolation valves 3" and larger:
    - a. 125-1b. SWP bronze gate valve with threaded ends
    - b. Bronze hand wheel
    - c. Screw-in bonnet
    - d. Non-rising stem
    - e. Solid wedge disc
    - f. Manufactured by Nibco Inc Model #F-619-RWS-SON, Milwaukee Valve Company #1140, or approved equal
- B. Quick-Coupling Valves: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.
- C. Automatic Electric Control Valves:
  1. Shall be as called out on Drawings and details.
  2. Normally closed, diaphragm type with manual flow adjustment, and operated by 24-V ac solenoid.



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3. Provide and install one control valve box for each electric control valve.

D. Check Valves:

1. In - line spring loaded check valves 2" and smaller shall be King Bros. Model KC, with PVC Type 1 construction with replaceable composition, neoprene or rubber disc and shall meet or exceed Federal Specification WW-V-51d, Class A, Type IV, or approved equivalent.
2. Anti-drain valves shall be of heavy-duty virgin PVC construction with FIP thread inlet and outlet. Internal parts shall be stainless steel and neoprene. Anti-drain valve shall be field adjustable against draw out from 5 to 40 ft. of head. The anti-drain valve shall be King Bros. Model CV or approved equivalent.

## 2.5 CONTROL WIRING

- A. Connections between the automatic controllers and the electric control valves shall be made with direct burial #14 AWG - UF 600 volt copper wire manufactured for irrigation system use.
- B. Use a different color wire for each automatic control valve.
- C. Common wires shall be white with a different color stripe for each automatic controller when multiple controllers are required.
- D. Install in accordance with valve manufacturer's specifications and wire chart. In no case shall wire size be less than #14.
- E. All control wire splices shall be made with waterproof wire connectors. Manufacturers: Spears Model No. DS-500 Dri-Splice, King Safety Products King 6 Blue, or approved equal. Use one splice per connector sealing pack.

## 2.6 TRACER WIRE

- A. No. 12. Green Type TW plastic-coated copper tracer wire

## 2.7 VALVE BOXES

- A. Plastic Valve Boxes (to be used when valve is in planting areas):
  1. For isolation valves, quick coupler valves, controller wire splices, or drain valves, use:
    - a. 10" diameter x 10" deep round box, Carson #910-4B, NDS Professional Series #212BC, or approved equivalent.
    - b. Use min 10" diameter extensions to achieve proper depth below assembly.
    - c. Lid shall be T-form, bolt-down type.
    - d. Label: heat brand lid with the text "IRR" in block letters.
  2. For Remote Control Valves, use
    - a. 11" x 17" rectangular box by Carson #1419-12-4B, NDS Professional Series #214BC, or approved equivalent.



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- b. Use 11" x 17" valve box extensions to achieve proper depth below assembly.
    - c. Lid shall be T-form, bolt-down type.
    - d. Label: heat-brand lid with the text "RCV" and the valve number in block letters.
  - 3. Brand boxes with a commercially produced branding iron, as manufactured by BrandNew Industries, Inc. (800) 964-8251, or equal.
- B. Concrete Valve Boxes (to be used when valve is in pavement):
- 1. For isolation valves, quick coupler valves, controller wire splices, or drain valves, use.
    - a. 9" diameter x 24" deep round box, Brooks Products #9 series, Christy Concrete Products Model #B3C or approved equivalent.
    - b. Lid shall be cast iron and
    - c. Label: permanently mark with the text "IRR" in block letters.
  - 2. For Remote Control Valves, use
    - a. 13" x 19" rectangular box by Brooks Products #3 series, Bes Concrete Products #C22E, or approved equivalent. Use 11" x 17" valve box extensions to achieve proper depth below assembly.
    - b. Lid shall be bolt-down type, cast iron.
    - c. Label: permanently mark lid with the text "RCV" and the valve number in block letters.

## 2.8 SPRINKLER HEADS

- A. All sprinkler heads shall be of the same size, type and deliver the same rate of precipitation with the diameter (or radius) of throw, pressure, and discharge as shown on the plans and/or specified in these Specifications.
- B. Spray heads shall have a screw adjustment.
- C. Riser units shall be fabricated in accordance with the details.
- D. Riser nipples and swing joints for all sprinkler heads shall be the same size as the riser opening in the sprinkler body.
  - 1. All sprinkler heads of the same type shall be of the same manufacturer.

## 2.9 TREE BUBBLERS

- A. Riser shall be a commercial grade, micro irrigation product. The riser length shall be as specified on the drawings and shall be made of highly flexible PVC and shall come with 1/2" MPT fittings on each side for connection. Color of the riser shall be brown. Working pressure shall be up to 60 PSI. Risers shall be installed with check valve filter screen.
- B. 2. Bubbler shall be pressure compensating with full circle discharge GPM rate as specified on the drawings. The bubbler shall be constructed of corrosion and UV-resistant plastic, with an integral elastomeric flow busing for maintaining a constant



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flow rate over the operating pressure range of 20 to 90 psi. The bubbler shall be compatible with a check valve filter screen to protect the nozzle from debris in the water. Bubbler shall have a ½-inch Female National Pipe Thread (FNPT) inlet for connection to a ½-inch male threaded riser.

- C. 3. Tree root watering system shall be as indicated on drawings or approved equal.

## 2.10 DRIP IRRIGATION EQUIPMENT

- A. Flexible tubing shall be fabricated from virgin Polyethylene resin as manufactured by Union Carbide DFDA 7510, with a minimum of 2% carbon black, specifically designed for drip irrigation use and conforming to the requirements of Specification ASTM D 1248 for Type I, Class C, Category 4 Grade P14, and to ASTM D-3350 for PE 122111C.
- B. Pressure rating of tubing shall be as defined in Standard ASAE S435. Burst strength shall be minimum 50 psi at 176 degrees F for 4,200 hours.
- C. Single and multiple outlet emitters shall be a self-flushing and pressure compensating type. Emitter bodies shall be constructed of durable UV resistant plastic. Regulating diaphragms shall be constructed of silicone rubber.
- D. In-line emitters shall have self-cleaning emitters impregnated with Treflan root growth inhibitor. Manufacturer: Toro; Model # DL2000.
- E. Flush valve: schedule 40 PVC ball valve as specified on plans.
- F. Air / vacuum relief valve: Toro YD-500-34.
- G. Pop-Up Indicator: Pop-up indicator shall be 6-inch high with yellow UV-resistant plastic and 1/2" FTP inlet.
- H. Screen filters shall be as manufactured by Amiad Inc. with pressure rating of 115 psi, and shall have manual flushing on/off control. Filter element shall be molded polyester screen cylinder with minimum 120 mesh screen.
- I. Preset pressure regulators shall be as manufactured by RainBird Inc. Model PSI-HMB for above or below ground application with 80psi max. Inlet pressure and 25 psi outlet pressure between 120 and 1320 gph.
- J. Flush end caps shall be self-flushing air release type as manufactured by Spot Systems (714) 891-1115.

## 2.11 AUTOMATIC IRRIGATION CONTROLLERS

- A. Controller(s) shall be the Calsense model CS3000 irrigation controller as indicated on the drawings, and shall be installed per manufacturer's specifications, as shown on the drawings, and as specified herein.



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- B. The irrigation controller shall have a 10-year, limited warranty.
- C. The irrigation controller shall have a large 5.7 inch backlit, ¼ VGA, LCD, sunlight readable display where information can be viewed on the same screen, and with a scrolling side menu design that makes programming intuitive and easy to follow.
- D. The controller shall be available in multiple station counts including 8, 16, 24, 32, 40 or 48 stations. If less than 48 stations are purchased initially, additional stations can be added at any time in the field using 8-station kits.
- E. The controller shall support up to 48 conventional-wired stations.
- F. Controller software upgrades shall occur via the internet transparently and at no charge.
- G. The controller shall have unlimited programs known as Station Groups which can water individually or concurrently to maximize irrigation system capacity and reduce watering time.
- H. The controller shall have the ability to assign landscape details such as plant material, head type, soil type and exposure to each Station Group to simplify programming of stations with similar characteristics. Each group shall include a variety of other settings including irrigation schedule, percent adjust factor, line-fill times, and on-at-a-time rules.
- I. The controller shall support up to four mainlines simultaneously for managing flow.
- J. The controller shall support up to 12 points of connection shared among controllers.
- K. The controller shall support up to 3 flow sensors and 3 master valves in a by-pass configuration to accurately measure and read the overall range of station flow rates from the lowest flowing station in GPM to the highest flowing station in GPM, using the 2Wire option and the 2-Wire, POC decoders for all 3 flow devices and master valves.
- L. The controller shall automatically calculate cycle and soak scheduling to water each station for a fixed cycle time and allow the water to soak in between cycles, maximizing infiltration and minimizing runoff.
- M. The controller shall have a water budget feature that displays monthly water volume allotments in either HCF or gallons for each of the 12 calendar months labeled as January through December. This monthly guideline shall be calculated three ways, either directly entered, calculated by the controller using a yearly budget and dividing that out to the 12 months proportionately using built-in historical ET, or by calculating the monthly numbers using total square footage and a user selected percent of historical ET.



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- N. The water budget shall be available per POC controlled and programmed for either every month or every other month pre-programmed as date ranges. If the expected water use for the period exceeds the water volume budget, the user shall be notified with an alarm before the period ends so changes to the program can be made. The controller shall not terminate irrigation automatically in this process, or if selected as an option, the controller shall proactively and automatically decrease the scheduled irrigation for each station group using the percent reduction programmed, when approaching the set water budget limit with notification of said action.
- O. The controller shall have a wide range of water reports and diagnostics available directly at the controller and shall include:
1. Summary of all usage for each irrigation mainline.
  2. Usage for each point of connection connected to the mainline
  3. Station-by-station usage
  4. A complete station-by-station history which includes the date and start time of each cycle, programmed minutes, programmed inches, number of cycles, actual flow rate, expected flow rate, and any alerts or issues that occurred during irrigation.
  5. Unscheduled water usage and non-controller water usage including quick coupler use and bleeding valves manually.
- P. The irrigation controller shall have three separate mainline break settings available for proper flow detection of catastrophic issues without interfering with standard irrigation practices and shall be programmed for 1.) 'During irrigation', 2.) 'Master valve override' functions, and 3) 'all other times'
- Q. The controller shall have flow management capability as a standard feature whereas the controller shall learn each station's expected GPM flow rate automatically at night over several irrigations, and use the mainline GPM capacity programmed, to operate up to six (6) valves at the same time to shorten the water window.
- R. The controller shall have the ability to accommodate multiple types of irrigation schedules including irrigating even days, odd days, prescribed days of the week, and interval scheduling ranging from every other day up to every four weeks.
- S. Several controllers, up to twelve, shall be able to share one or multiple points of connection with multiple flow sensors and master valves. This option shall allow several controllers without the use of a central control computer to share the irrigation programs and flow information for:
1. Monitoring of system flows.
  2. Shortening water windows by maximizing the number of valves on without exceeding system flow capacity.
  3. Turning OFF valves with excessive flow rates due to broken lateral lines.
  4. Tracking water usage and comparing to a water budget.
  5. Eliminating relays when sharing pumps and master valves.
- T. When more than one controller is sharing one or multiple points of connection and the controllers are communicating to each other through hardwire or radio, the data shall be distributed as changes occur making the data available from any controller on the



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FLOWSENSE™ chain so that the user shall be able to view and program a controller's information from any other controller in the group.

- U. The controller shall provide permanent memory stores of all controller programming and setup data, including date and time, in non-erasable memory.
- V. The controller shall have the ability to create and program an unlimited number of manual programs which allow the user to schedule stations to run for a preset time, up to 6 times per day, for hydro-seeding, new planting, and fertilization scheduling.
- W. Electrical alerts, such as short circuits and no currents, shall be standard to help the user troubleshoot field wiring and solenoid problems.
- X. Pedestal Enclosure:
  - 1. The enclosure shall be of a vandal and weather resistant nature manufactured entirely of 304-grade stainless steel, and the top shall be 12 gauge and the body 14 gauge. The main housing shall be louvered upper and lower body to allow for cross flow ventilation. A stainless-steel backboard shall be provided for the purpose of mounting electronic and various other types of equipment. The stainless-steel backboard shall be mounted on four stainless steel bolts that will allow for easy removal of the backboard.
  - 2. The 38-inch height with flip top shall provide easy access for programming from a standing position under normal installations.
  - 3. The pre-assembled vandal resistant enclosure factory pre-assembled and supplied by controller manufacturer shall come complete with 24 VAC lightning and surge protection and all terminals shall be factory labeled. The pre-assembled enclosure shall come provided with an On/Off switch to isolate the controller along with a GFI receptacle. Specific radio antenna(s) shall be pre-mounted and connected on enclosure. The enclosure shall include 2-7/8", 1-1/2" thick, 6-pin cylinder, die-cast steel padlock with unique shackles design.
  - 4. Factory pre-assembled enclosure with controller shall carry a full UL listing. E. Controller manufacturer shall offer a double-wide, pre-assembled vandal resistant enclosure, 38-inch height with flip top for two controller placements side by side. All necessary wiring between the two controllers in order to share central communications and/or flow and weather data shall be pre-wired by manufacturer for easy installation.
  - 5. The factory pre-assembled enclosures shall carry a ten (10) year limited warranty.
- Y. Grounding:
  - 1. Grounding shall consist of one 5/8-inch x 8-foot copper rod installed per irrigation controller and where multiple controllers are not connected to the same ground rod.
  - 2. The top of each rod shall be installed inside a 10-inch round valve box, with the rod installed as close as practical to the controller. If a pedestal enclosure is used, the ground rod may be installed through the pedestal base. Under no circumstances shall the rods be shortened.



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3. A #6 AWG solid copper wire shall be used to connect from the ground lug of the transient protection board to the copper rod. Brass clamps specifically designed to secure the copper wire to the grounding rod shall be used. There shall be no kinks or sharp bends in the wire.
4. Each wire may be wrapped around the rod and brazed in place as an alternative to clamping. Braze the wire to the rod for at least one circumference of the rod.

Z. Weather Monitoring:

1. The manufacturer of the central control system shall provide real-time ET and rain data using multiple, state-of-the-art, high resolution numerical weather data provided by NOAA, all without subscription charges. Unlike other services which use only ground level weather stations, the NOAA-modeled data shall allow weather to be triangulated to each customer's unique latitude, longitude, and elevation, ensuring accuracy even within localized microclimates. ET shall be calculated using the latest FAO Penman-Monteith method which shall use solar radiation, temperature, wind speed, relative humidity, and other input parameters.
2. The user shall be able to cap the amount of daily ET used by the controller for that night's calculation by selecting a percent of historical ET for the given area to be used instead of the actual ET received.
3. The irrigation controller shall have the capability to calculate station run times using the average of the last 7 days of ET instead of using a single ET value to calculate the next scheduled station run times.
4. The controller shall be able to interface directly with a Tipping Rain Bucket and shall accurately measure rainfall in 0.01" increments by means of a tipping and emptying device mounted below the center of the collection dish.
5. The irrigation controller shall provide the following programming parameters for rain: Stop Irrigation after x. xx inches Maximum Rain in One Hour is x. xx inches Maximum Rain in 24 Hours is x.xx inches.

AA. Flow Monitoring:

1. The flow sensor shall be wired back to the irrigation controller using two #14 AWG wires, one red, and one black in 1" PVC conduit to connect to the irrigation controller. The maximum wire run between flow meter and controller shall be 2000 ft. The flow meter shall send low voltage digital pulses back to the controller and therefore all electrical connections must be waterproof and be resistant to any moisture entry.
2. It is intended that all wire runs between the controller and flow meter should be direct pulls and have no splices. If wire splices are unavoidable, they must be installed in a valve box with Spears DS-100 connectors with Spears sealant or 3M Scotchlok No. 3570 connector sealing pack used.
3. Each flow sensor shall have the following characteristics:
  - a. Housing to be a Sch 80 polyvinyl chloride tee or bronze tee.
  - b. Have a pulsing output that operates at 9VDC and a pulse rate that is proportionate to the GPM.
  - c. Fully compatible with the internal interface at each field controller
  - d. Powered by the controller



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- e. Replaceable metering insert
  - f. Shall feature a six-bladed design with a proprietary, non-magnetic sensing mechanism.
4. The irrigation controller shall include native support for Bermad 900-M Reed Switch and Netafim Pulse Reed Switch series hydrometers. Allowable hydrometer sizes shall range from 1.5" to 10". Reed Switches that are supported include 1-pulse per 1-gallon and 1pulse per 10-gallon switches. Currently only one hydrometer mentioned shall be able to interface with the controller.
- BB. Central Control Communication:
- 1. The field controller(s) shall be capable of utilizing a single mode or a combination of communication modes such as 3.5G cellular radio, Ethernet, wireless Ethernet, 450470HMz Local Radio, point-to-point Spread Spectrum radio, and hardwire communication cable for central control of irrigation via cloud-based, Command Center Online web software.
  - 2. The controller shall be able to utilize a wireless, 3.5G cellular radio in remote areas where an Ethernet or Wi-Fi connection is not possible for direct communication back to a desktop, tablet, or laptop computer via the Internet. Service plans for single and multiple controllers utilizing a 3.5G cellular modem shall be available through the manufacturer as 1-year or 5-year plan.
  - 3. The controller shall be able to utilize an Ethernet communication, CAT5 or CAT6 cable path as part of a district's or campus network system. An Ethernet (RJ45) connection shall be supplied at the controller location, with the network set to have access to this connection. IP reservations with DHCP are preferred along with the hard coded MAC address from the Ethernet device supplied. The secondary preference shall be a static IP address with additional programming requirements. The controller shall utilize an existing Wi-Fi, wireless Ethernet network on a school campus or facility city project. IP reservations with DHCP are preferred along with the hard coded MAC address from the Ethernet device supplied.
  - 4. The controller shall be able to utilize a short-range, Spread-Spectrum radio to communicate with other controllers in line-of-sight proximity providing a reliable communication link instead of a hardwire communication path when sharing data. The spread-spectrum radio option does not require FCC licensing and offers a secure error correcting frequency hopping radio link immune to outside interference.
- CC. Command Center Online Web Software Compatibility:
- 1. The field controller(s) shall be capable of communicating with the City of Santee cloud-based central control software.
- DD. Warranty, Service and Training:
- 1. The manufacturer shall provide after-sale support that is a no charge service whereas ongoing training and education shall be provided by factory direct personnel to the end user(s) at the field controller(s) and using the cloud-based, web software for central control of irrigation.



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2. The central control manufacturer shall warrant to the purchaser of its manufactured products against defects in material and workmanship for a period of ten (10) years from the date of original purchase by the owner.
3. All peripheral, accessory, and RF equipment such as radio and 3.5G cellular radio modems, ET gages, flow sensors, and rain buckets (but not limited to) and used in conjunction with central irrigation controllers, shall have distinct warranties of their own and should be noted separately from this warranty.

2.12 ELECTRICAL REQUIREMENTS TO AUTOMATIC CONTROLLER

1. Service to automatic controllers and final hook up shall be provided by electrical subcontractor.
2. Electrical equipment installed outside building shall be NEMA 4 type.
3. All connections between electrical services and equipment shall be in rigid galvanized electrical conduit, with conduit and wiring size as required.
4. To be complete in every respect to National Electrical Code, ready for use and in accordance with manufacturer's requirements. Provide separate power shut off switch at panel for each controller. All wiring in galvanized conduit and fittings from source provided under the electrical section. No running threads accepted; use nipples. Conduit system shall be 660-volt insulation, NEC standard annealed copper wire and shall be minimum AWG #12 TW or RW. Protect each controller by a code approved ground connection. Supply to be 120 volts, 60 cycle, single phase, one amp. Use only galvanized steel fasteners in securing controllers in position. Install new controller as detailed on drawings.

2.13 ADDITIONAL MATERIALS

- A. Primer: Shall be IPS Corporation Weld-on #P-70, or approved equal
- B. Cement:
  1. IPS Corporation Weld-on #P-705 for Class 200 PVC or Schedule 40 PVC (up to six inches (6") diameter). IPS Corporation Weld-on #711 shall be used for larger pipe diameters and Schedule 80 PVC or approved equal.
  2. PS Corporation Weld-on #P-795 for flexible PVC to rigid PVC connections or approved equal.
- C. Pipe Joint Compound
  1. Joint compound to be non-hardening, formulated for threaded connections on water carrying pipe, Lasco Blue Pipe thread sealant or approved equal.
- D. Pipe Thread Tape
  1. Pipe thread tape shall be 100% virgin Teflon pipe thread tape.
- E. Remote Control Valve Identification Tags
  1. 2-1/4 by 2-3/4-inch yellow polyurethane with valve number embossed on tag.
- F. Trench Backfill Material:
  1. Sand shall be a utility sand white in color and jetted lightly after being placed in trench. Sand backfill shall be used for all pressure mainline pipes.



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G. Corrosion Protection

1. Provide polyethylene wrap a minimum of six (6) mils. Thickness for all metal pipe, fittings, tie-rods, valves, and other appurtenances. The raw material must meet or exceed: Type 1, Class A Grade E-1, in accordance with ASTM Standard Designation D-1248; a tensile strength of 1,200 PSI minimum; elongation of 300% minimum and dielectric strength of 800V/Mil thickness minimum.

H. Concrete

1. 2,500 lb. strength at 28 days. Fine aggregate may be granular sand. All rock and gravel for use in concrete shall be mechanically washed and free from injurious amounts of deleterious substances.

### PART 3 - EXECUTION

#### 3.1 INSPECTION OF EXISTING SITE CONDITIONS

- A. Before any work begins, a conference shall be held with the Owner's authorized representative and the Contractor regarding general requirements for the project.
- B. It is the responsibility of the Contractor to familiarize himself with future locations of walls, paving, grade differences, etc. He shall coordinate his work with the General Contractor and other SubContractors for the location and installation of pipe sleeves through walls, footings, under paving, etc., and so that there is no difficulty in the subsequent planting of trees or shrubs which are shown in the plans.
- C. Exercise extreme care in excavating and working near existing utilities. Contractor shall be responsible for damages to utilities that are caused by his operation or neglect. Check existing utilities Drawings for existing utility locations. Before excavating, call Underground Service Alert, (800) 422-4133
- D. Contractor shall not willfully install the sprinkler system as shown on the Drawings when it is obvious in the field that obstructions, grade differences, or differences in dimensions of areas exist that might not have been considered in the engineering.
  1. Such obstructions or differences shall be brought to the attention of the Owner's authorized representative.
  2. In the event this notification is not performed, the Contractor shall assume full responsibility for any revisions necessary.
- E. Contractor shall carefully check all grades to satisfy for himself that he may safely proceed before starting work on the sprinkler irrigation system.

#### 3.2 PREPARATION

- A. Physical Layout: Prior to installation, the Contractor shall stake out all pressure supply lines, routing and location of sprinkler heads. All layouts shall be approved by Architect prior to installation.



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### 3.3 WATER SUPPLY

- A. The Contractor shall verify static pressure on site prior to commencement of any work.
- B. The system design is based upon the minimum operating pressure and maximum flow demand shown on the Drawings.
  - 1. Contractor shall report any difference between the water pressure shown on the Drawings and the actual pressure at the point of connection to the Owner's authorized representative.
- C. All work required for proper point of connection and laying of irrigation supply line shall be in accordance with all applicable codes and ordinances.
- D. Connections shall be made at approximate locations as shown on Drawings. Contractor is responsible for minor changes caused by actual site conditions.
- E. Where connections are made between new work and existing water mains, the connections shall be made by using special couplings, Rockwell Clamp and Coupling-Tapping Sleeves, or equal, and other fittings to suit the on-site conditions.
  - 1. Methods of connections to existing mains shall be as required by local codes.
  - 2. All connections shall be constructed with approved materials and installation methods that meet or exceed individual public utility agency standards.
- F. Irrigation on this site has been designed for the use of non-potable water.

### 3.4 INSTALLATION

- A. Trenching
  - 1. Dig trenches straight and support pipe continuously on bottom of trench. Lay pipe to even grade. Trenching excavation shall follow layout indicated on Drawings and as noted.
  - 2. Provide for a minimum of 18" cover for all pressure supply lines.
  - 3. Provide for a minimum cover of 12" for all non-pressure lines.
  - 4. Where it is necessary to excavate adjacent to existing trees, Contractor shall use all possible care to avoid injury to trees and tree roots.
    - a. Excavation in areas where two-inch and larger roots occur shall be done by hand.
      - 1) All roots two inches and larger in diameter, except directly in the path of pipe or conduit, shall be tunneled under and shall be heavily wrapped with burlap to prevent scarring or excessive drying.
    - b. Where a ditching machine is run close to trees having roots smaller than two inches in diameter, the wall of the trench adjacent to the tree shall be hand trimmed, making clean cuts through.
    - c. Roots one inch and larger in diameter shall be painted with two coats of Tree Seal or equivalent.



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- d. Trenches adjacent to trees should be closed within 24 hours, and where this is not possible, the side of the trench adjacent to the tree shall be kept shaded with burlap or canvas.
- 5. Provide for a minimum cover of 18" for all control wiring.

B. Backfilling - General

- 1. The trenches shall not be backfilled until all required tests are performed. Trenches shall be carefully backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand or other approved materials, free from large clods of earth or stones. Backfill shall be mechanically compacted in landscaped areas to a dry density equivalent to adjacent undisturbed soil in planting areas. Backfill will conform to adjacent grades without dips, sunken areas, humps or other surface irregularities.
- 2. A fine granular material backfill will be initially placed on all lines. No foreign matter larger than 1/2" in size will be permitted in the initial backfill.
- 3. Flooding of trenches will be permitted only with approval of the Architect.
- 4. If settlement occurs and subsequent adjustments in pipe, valves, sprinkler heads, lawns, planting, paving or other construction are necessary, the Contractor shall make all required adjustments without cost to the Owner.

C. Trenching and Backfill Under Paving

- 1. Trenches located under areas where paving, asphaltic concrete or concrete will be installed shall be backfilled with sand (a layer three inches below the pipe and three inches above the pipe) and compacted to 90% compaction, using manual or mechanical tamping devices. Trenches for piping shall be compacted to equal the compaction of the existing adjacent undisturbed soil and shall be left in a firm unyielding condition. All trenches shall be left flush with the adjoining grade. Contractor shall set in place, cap, and pressure test all piping under paving prior to the paving work.
- 2. Generally, piping under existing walks is done by jacking, boring or hydraulic driving, but where any cutting or breaking of sidewalks and/or concrete is necessary, it shall be done and replaced by the Contractor as part of the contract cost. Permission to cut or break sidewalks and/or concrete shall be obtained from the Architect. No hydraulic driving will be permitted under concrete paving.
- 3. Provide for a minimum cover of 24" between the top of the pipe and the bottom of the aggregate base for all pressure and non-pressure piping installed under asphaltic concrete paving.

D. Assemblies

- 1. Routing of sprinkler irrigation lines as indicated on the Drawings is diagrammatic. Install lines and various assemblies to conform to the details shown on Drawings.
- 2. Perform all directional changes using 45-degree elbows. No 90-degree elbows will be permitted without approval of Architect.
- 3. Install all assemblies in accordance with respective detail. In absence of detail Drawings or Specifications pertaining to specific items required to complete



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- work, perform such work in accordance with best standard practice with prior approval of Architect.
4. PVC pipe and fittings shall be thoroughly cleaned of dirt, dust and moisture before installation. Installation and solvent-welding methods shall be as recommended by the pipe and fitting manufacturer.
  5. On PVC to metal connections, the Contractor shall work the metal connections first. Teflon tape or approved equivalent shall be used on all threaded PVC-to-PVC joints, and on all threaded PVC-to-metal joints. Light wrench pressure is all that is required. Where threaded PVC connections are required, use threaded PVC adapters into which the pipe may be welded.
  6. Joining by Ring Seal
    - a. Provide for expansion and contraction at each end. Use rubber ring and lubricate with non-toxic lubricant. Center load, leaving all connections exposed. Do not lay pipe in trench containing water or at less than 32 degrees F.
  7. Joint Restraints
    - a. Ductile iron joint restraints shall be installed on all fittings and gate valves for all IPS-Size, ring joint PVC pipe. The joint restraint shall be capable of securing the PVC pipe directly to the lugs on the Leemco and HARCO deep bell ductile iron fittings without the use of bolts, links, and adapters. The joint restraint shall be capable of securing PVC pipe to PVC pipe and PVC pipe to ring joint gate valves without the use of threaded linkages.
    - b. All ductile iron fittings shall be secured to full-length pipes and on all bends and tee branches, the next joint of the pipe shall be secured. At least two full lengths of pipe must be secured when attached to bends and tee branched 8" and larger, and at least three full lengths when attached to a fitting shall also be secured.
- E. Line Clearance: All lines shall have a minimum clearance of six inches from each other and from lines of other trades. Parallel lines shall not be installed directly over one another.
- F. Automatic Controller
1. Install as per manufacturer's instructions. Remote control valves shall be connected to the controller in numerical sequence shown on the Drawings. If multiple Controllers are installed, clearly label the Controller on the outside of its access door with a permanent weatherproof identification letter or number.
  2. The Architect shall approve the final location of automatic controllers. Unless otherwise noted on the plans, the 120-volt electrical power to the automatic controller location to be furnished by others. The final electrical hookup shall be the responsibility of the irrigation Contractor. All electrical work shall conform to local codes, ordinances, and governing authorities having jurisdiction.
  3. Pedestal mount controllers are to be fully grounded, per drawings.
- G. Control Wiring
1. Wiring shall occupy the same trench and shall be installed along the same route as pressure supply or lateral lines wherever possible.



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- a. Control wires shall be laid loosely in trench without stress or stretching of control wire conductors.
    - b. Where more than one wire is placed in a trench, the wiring shall be taped together at intervals of 10 feet.
  2. An expansion curl shall be provided within three feet of each wire connection.
    - a. The expansion curl at each splice connection and at each electric control valve shall be long enough to bring the valve bonnet to the surface without disconnecting the control wires.
  3. Field splices between the automatic controller and electrical control valves will not be allowed without prior approval of the Architect, and if approved, shall be protected by a valve box type enclosure.
  4. A minimum of one additional blank remote control valve station wire shall be run from the controller to the furthest point of each separate leg of the mainline. Terminate wire in nearest valve box and tag "blank" in valve box and in controller.
- H. Tracer Wiring
  1. Place No. 12 gauge copper identification wire at bottom of trench for all mainline PVC pipe.
    - a. Use separate segment of wire between each pair of valves along the length of the mainline.
    - b. Wrap each end around the valve body, leaving at least a two-foot length of wire free.
    - c. Neatly coil the excess two feet of wire and place in valve box.
- I. Remote Control Valves: Install where shown on Drawings and details.
  1. When grouped together, allow at least 12" between valves. Install each control valve in a separate box. Use approved plastic valve box extensions to proper depth below pipeline.
  2. Locate valve boxes 12" from, and perpendicular to, adjacent paving.
- J. Low Head Drainage: It is the intention of the design to indicate check valves and/or low head drain valves in order to prevent water from running out of sprinkler heads when systems are shut off. The Contractor shall include as part of the cost of his work installing any necessary check valves and/or low head drain valves which are necessary and may not be shown on the plans.
- K. Flushing of System
  1. After all new sprinkler pipe lines and risers are in place and connected, and prior to installation of sprinkler heads, the control valves shall be opened and full head of water used to flush out the system.
  2. Sprinkler heads shall be installed only after flushing of the system has been accomplished to the complete satisfaction of the Architect.
- L. Sprinkler Heads
  1. Install the sprinkler heads as designated on the Drawings. Sprinkler heads to be installed in this work shall be equivalent in all respects to those itemized.



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2. Spacing of heads shall not exceed the maximum indicated on the Drawings. In no case shall the spacing exceed the maximum recommended.

M. Drip Irrigation installation

1. Install control valves and rigid PVC distribution lines prior to planting operations.
2. After container plants 1 gallon and larger are planted and grades are finished, install drip hoses and emitters. Bury drip tubing 4" deep unless specified differently in the plans and details.
3. Flush and adjust systems, eliminate leaks, operate for a one-hour period, then re-check and re-adjust systems.
4. Complete planting and mulching operations.

### 3.5 TEMPORARY REPAIRS

- A. The Owner reserves the right to make temporary repairs as necessary to keep the sprinkler system equipment in operating condition. The exercise of this right by the builder/developer shall not relieve the Contractor of his responsibilities under the terms of the guarantee as specified herein.

### 3.6 FIELD QUALITY CONTROL

A. Adjustment of the System

1. The Contractor shall flush and adjust all sprinkler heads for optimum performance and to prevent over-spray onto walks, roadways, and buildings.
2. If it is determined that adjustment in the irrigation equipment will provide proper and more adequate coverage, the Contractor shall make such adjustments prior to planting. Adjustments may also include changes in nozzle size and degrees of arc as required.
3. When the radius of any sprinkler head requires downward adjustment to better suit actual conditions, the Contractor shall install pressure-compensating screens by the same manufacturer as the sprinkler nozzle, for flow and radius control.
4. The Contractor shall lower raised sprinkler heads within 10 days after notification by Owner.
5. All sprinkler heads shall be set perpendicular to finished grades unless otherwise designated on the plans.
6. It is the intent of the design to install pop-up heads adjacent to any pedestrian circulation. In the event of an area of pedestrian circulation does not have pop-up heads specified, it shall be the responsibility of the Contractor to bring this to the attention of the Architect or install the pop-up heads to match those specified.

B. Testing of Irrigation System

1. Automatic Controller Grounding
  - a. Test for proper grounding of control system per manufacturer's recommendations. Test results must meet or exceed manufacturer's guidelines for acceptance.



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- b. Automatic Irrigation Control System shall be grounded and conform to requirements of the National Electric Code, current edition as adopted by local code, and the manufacturer's specifications. No solder connections will be allowed. Resistance to ground shall be no more than 25 ohms.
  - c. Test to verify proper grounding.
  - d. Replace defective wire, grounding rods, grounding plates, or appurtenances. Repeat test until manufacturer's guidelines are met.
  - e. Consult the ASIC Earth Grounding Electronic Equipment in Irrigation Systems—Guidelines for correct minimum recommended distances for different grounding rod or grounding plate sizes and grounding grid designs.
2. Tracer Wire Test
  - a. Pass current through wire and demonstrate that wire is capable of locating the pipe.
  - b. If wire will not pass the current, locate break and test until tracing wire works in accordance with its intended use.
3. Valves
  - a. The Contractor shall adjust all remote control valves to close within forty-five (45) seconds to one minute upon shutdown from the irrigation controller.
4. Test all pressure lines under hydrostatic pressure of 150 lbs./sq.in. and prove watertight. Note: testing of pressure main lines shall occur prior to installation of electric control valves.
5. All piping under paved areas shall be tested under hydrostatic pressure of 150 lbs./sq.in. and prove watertight prior to paving.
6. Sustain pressure in lines for not less than two hours. If leaks develop, replace and repeat test until entire system is proven watertight.
7. All hydrostatic tests shall be made only in the presence of the Architect or other duly authorized representative of the Owner. No pipe shall be backfilled until it has been inspected, tested and approved in writing.
8. Furnish necessary force pump and all other test equipment.
9. When the sprinkler irrigation system is completed, perform a coverage test to determine if the water coverage for planting areas is complete and adequate. Furnish all materials and perform all work required to correct any inadequacies of coverage. This test shall be accomplished before any ground cover is planted or inspections are requested.
10. Upon completion of each phase of work, entire system shall be tested and adjusted to meet site requirements.
11. The entire sprinkler irrigation system shall be under full automatic operation for a period of seven days prior to any planting.
12. The Architect reserves the right to waive or shorten the operation period.

### 3.7 CLEAN-UP

- A. Cleanup shall be made as each portion of work progresses.
  1. Refuse and excess dirt shall be removed from the site.
  2. All walks and paving shall be swept or washed down.



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3. Any damage sustained on the work of others shall be repaired to original conditions acceptable to Owner and Architect.
- B. Cleanup shall be performed at the end of each working day, and a maximum cleanup effort shall be made for each weekend by the Contractor in a manner satisfactory to the Owner.

### 3.8 FINAL OBSERVATION PRIOR TO ACCEPTANCE

- A. The Contractor shall operate each system in its entirety for the Architect at time of final observation. Any items deemed not acceptable shall be reworked to the complete satisfaction of the Architect.
- B. The Contractor shall show evidence to the Architect that the Owner has received all accessories, extra parts, charts, record Drawings, and equipment as required before final observation can occur.

### 3.9 OBSERVATION SCHEDULE

- A. Contractor shall be responsible for notifying the Architect in advance for the following observations according to the time indicated:
  1. Pre-job Conference - Seven days.
  2. Pressure supply line installation and testing - 48 hours.
  3. Automatic controller installation - 48 hours.
  4. Control wire installation - 48 hours.
  5. Lateral line and sprinkler installation - 48 hours.
  6. Coverage test - 48 hours.
  7. Final observation - Seven days.
- B. When inspections have been conducted by other than the Architect, show evidence of when and by whom these inspections were made.
- C. No observation shall commence without adequate preparation or as-built Drawings. In the event the Contractor calls for an observation without as-built Drawings without completing previously noted corrections, or without preparing the system for observations, he shall be responsible for reimbursing the Architect at the hourly rate in effect at the time the observation portal-to-portal (plus transportation costs) for the inconvenience. No further inspections will be scheduled until this charge has been paid.

### 3.10 RECLAIMED WATER SYSTEM OPERATION/MAINTENANCE

- A. Only the water supplier or others approved by the water supplier are allowed to work on either the potable or the reclaimed water system piping.
- B. Designate a Reclaimed Water User Supervisor (Supervisor) and advise the District if the Supervisor, as named on the Permit for Reclaimed Water Service, is changed.



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1. The Supervisor shall be aware of the entire system within his or her responsibility and of all applicable conditions of reclaimed water use. The Supervisor shall be responsible for the installation, operation and maintenance of pipelines and cross-connection equipment.
  2. The owner/Supervisor shall be responsible for the operation and surveillance of on-site reclaimed water distribution facilities to avoid cross-connections. Cross connection between the potable water system and the reclaimed water system is not to take place under any circumstances.
  3. The Reclaimed Water User Supervisor shall maintain record and "as-built" Drawings of all reclaimed water and potable water systems.
- C. Submit revised Drawings and obtain prior District approval for any significant changes proposed for the approved irrigation system.
- D. To the extent possible, the operation of the irrigation system should be during periods of minimal public use of the approved area.
- E. The District shall conduct annual cross-connection surveys and visual inspections for possible cross-connection with the potable water system.
1. Pressure tests shall be conducted every four years.
  2. If cross connection is observed, both water systems shall be immediately shut off, and the cause of cross-connection shall be remedied.
- F. The District shall have access to reclaimed water user facilities on a 24-hour basis.
- G. Maintain the irrigation system properly to minimize failures and repair broken valves, pipes and sprinklers in a timely fashion.
- H. When irrigating, minimize ponding, and runoff. If necessary, use the "repeat" function of the irrigation controller to apply the required amount of water in several short duration cycles.
- I. Adjust sprinklers to avoid reclaimed water spray on picnic tables, benches, docks, patios, sidewalks, roads and drinking fountains.
- J. Prevent people from drinking reclaimed water.
- K. Prevent the washing of food in reclaimed water.
- L. Avoid direct spray and overspray on drinking fountains in areas irrigated with reclaimed water.
- M. Hose bibs are not permitted on the reclaimed water irrigation system. Quick couplers should be used if hose connections are necessary for handheld irrigation.
- N. User personnel shall receive annual training from the District.



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- O. Educate occupants, residents and maintenance personnel on a continuous basis to be sure they understand the proper use of reclaimed water.

END OF SECTION



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SECTION 32 90 00 – LANDSCAPE PLANTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes materials, soil and installation in over-structure planters, soil preparation, planting, palm planting, seeding, sodding, staking and guying, and cleanup.
  - 1. Planting occurs at street level and on upper building levels.
- B. Related work:
  - 1. Section 32 01 30: Operation and Maintenance of Site Improvements
  - 2. Section 32 84 00: Landscape Irrigation
- C. Definitions:
  - 1. Architect: the Architect or the Owner's authorized representative.
  - 2. Soil Test: Required testing performed by Contractor after site is rough graded. A current soil report is also required for import soil prior to transport to the site.
  - 3. Punch List: List of work within the Contract, generated by Architect that needs to be completed, repaired, replaced, or rectified by Contractor.
  - 4. Pre-maintenance review: Observation by Architect to verify substantial completion of the Work. The Architect will generate a Punch List during this review. Maintenance Period will commence when Contractor has completed items on this Punch List and Architect has verified that the Punch List is complete.
  - 5. Maintenance Period: See Specification section 32 01 90.
  - 6. Final Acceptance: Observation review by Architect at end of the specified Maintenance Period to verify completion and acceptance of the Work.

1.2 QUALITY ASSURANCE

- A. Standards:
  - 1. Provide plants and planting materials that meet or exceed specifications of Federal, State, and County laws requiring inspection for plant disease or insect control.
  - 2. Provide quality and size conforming to current edition of "Horticultural Standards" for number one nursery stock as adopted by the American Association of Nurserymen.
  - 3. Provide plants that are true to name. Tag one of each bundle or lot with the name and size of plants in accordance with the standards of practice of the American Association of Nurserymen.
  - 4. Botanical names shall take precedence over common names.
- B. Workmanship: Perform work in accordance with the best standards of practice for landscape work and under the continual supervision of a competent foreman capable of interpreting the Drawings and Specifications.



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- C. Quantities and Types: Plant materials shall be furnished in the quantities and/or spacings as shown or noted for each location, and shall be of the species, kinds, sizes, etc., as symbolized and/or described in the Plant List, and as indicated on the Drawings.
- D. Verification of dimensions and quantities: scaled dimensions are approximate. Before proceeding with work, carefully check and verify dimensions and quantities and immediately inform the Architect of discrepancies between the Drawings and/or specifications and actual conditions. Do not start work in areas where there are discrepancies until approval for same has been given by the Architect.

### 1.3 SUBMITTALS

- A. Submit documentation to Architect 60 days before start of planting that plant material is available. Include:
  - 1. A list of plants stating quantity, size, and supplier.
    - a. Requests for substitutions due to unavailability must be made in writing.
    - b. Substitutions may not be made without approval of the Architect.
    - c. Contractor shall notify Architect 24 hours in advance of delivery of plant materials, and shall submit an itemized list of plants in each delivery.
  - 2. Photographs of trees 24" box and larger.
    - a. Label each photo with plant name, plant height, spread and trunk caliper.
    - b. Label each photo with nursery name, nursery contact and phone number.
    - c. Photograph shall include a person or measuring stick in each picture for scale purposes.
- B. Soil Test: Contractor shall have import soil and the soil of the site tested for fertility, agricultural suitability, and appraisal by Soil and Plant Laboratory Inc. (714) 282-8777, or Wallace Labs (310) 615-0116 or approved equal.
  - 1. Submit a copy of the Planting Plan and Plant Legend to the laboratory with the samples.
  - 2. Soil report shall include:
    - a. pH measurement.
    - b. Nutrients and elements:
      - 1) Measurement (low, medium, high) of: Boron, calcium, copper, iron, magnesium, manganese, molybdenum, phosphorus, potassium, sodium, sulfur, and zinc.
      - 2) Analyze saturation extract for: calcium, magnesium, sodium, boron, chloride, phosphorus, nitrate and sulfate.
      - 3) Trace metals: Aluminum, arsenic, cadmium, chromium, cobalt, lead, lithium, nickel, selenium, silver, strontium, tin and vanadium.
      - 4) The presence of calcium carbonate and/or magnesium carbonate.
    - c. Soil Texture (gravel, sand, silt and clay). Determine organic matter content by the measurement of organic carbon. The quality of the organic matter shall be determined by measuring organic carbon and total nitrogen.
      - 1) Methods of Soil Analysis, Part 1, Physical and Mineralogical Methods, Soil Science Society of America, Inc., 1986, chapter 36, pgs 901-926 and Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science



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Society of America, Inc, 1996, chapter 34, pgs 965-977 & pgs 1001-2  
and chapter 37, pg 1088

- d. Interpretation and recommendations for correction of nutritional deficiencies/ excesses and potential toxicities.
- 3. Soil shall be tested from a minimum of four (4) locations per acre of planted area. Contractor shall record locations where samples were taken.
- 4. A copy of the soil test results shall be submitted to the Owner and Architect before work begins.
- 5. Contractor shall pay cost of soil tests.
- C. Cut sheets of materials to be used: tree stakes, tree guys, root barriers, amendments, mycorrhizal fungi, etc.
- D. Legible copies of delivery slips for soil amendments, including mycorrhizal fungi.
- E. The Contractor shall submit samples or specifications of items being used upon the request of the Architect, and as required by this Part 2 of this Specification.

#### 1.4 OBSERVATION SCHEDULE

- A. Contractor shall be responsible for notifying the Architect, in advance, for the following observations, according to the time indicated:
  - 1. Pre-construction conference – seven (7) days
  - 2. Tree tagging at nursery (trees 24" box size and larger) – 48 hours
  - 3. Final grade, soil preparation and planting area layout review - 72 hours
  - 4. Plant materials review - 48 hours
  - 5. Plant layout review - 48 hours
  - 6. Planting operations - 48 hours
  - 7. Completed planting (Pre-maintenance) walk through – seven (7) days
- B. Contractor shall be responsible for scheduling site Observation visits with Architect as work progresses. Failure to schedule required Observations shall not relieve Contractor of responsibility for obtaining approvals. Contractor shall redo, at no cost to the Owner, work that does not satisfy the Owner.
- C. Observations may be waived or combined at the discretion of the Architect.
- D. When someone other than the Architect conducts Observations, the Contractor shall show evidence in writing of when and by whom these observations were made.
- E. No site visits shall commence without adequate preparation or items noted in previous Observation Reports, either completed or remedied, unless the Owner has waived such compliance. Failure to adequately prepare or accomplish previous punch list items shall make the Contractor responsible for reimbursing the Architect for the site visit at his current billing rates per hour plus transportation costs. No further inspections will be scheduled until this charge has been paid and received.



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1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver fertilizer or soil amendments to site in original unopened containers bearing manufacturer's guaranteed chemical analysis, name, trademark, and conformance to state law. Protect material from damage or breakage. Immediately remove empty containers from site.
- B. Deliver plants with legible identification labels. Store plant material in shade and protect from weather or injury. Maintain in a healthy, vigorous condition. Architect may at time reject plant material not maintained in this condition.
- C. Handling: Do not drop plants or pick up container plants by their stems or trunks.

1.6 SAMPLES AND TESTS:

- A. Contractor shall submit soil samples for testing, per this Specification.
- B. Architect reserves the right to take and analyze samples of materials for conformity to specifications at any time. Contractor shall furnish samples upon request by Architect.
- C. Rejected materials shall be immediately removed from the site at the Contractor's expense.
- D. Contractor shall pay cost of testing or replacement of materials not meeting specifications.

1.7 WARRANTY AND REPLACEMENT

- A. Contractor shall fully warrant and agree to replace poor, inadequate, or defective materials and workmanship for one year from date of acceptance of completed planting work.
- B. Replacement: Materials found to be dead, missing, or in poor condition during the establishment period shall be replaced immediately. The Architect shall be the sole judge as to the condition of material. Material to be replaced during the warranty period shall be replaced by the Contractor within fifteen days of written notification by Owner.

PART 2 - PRODUCTS

2.1 SOIL

- A. Site Soil:
  - 1. Site soil used to form landscape planting areas or backfill planters shall be clean, fertile, loamy soil, free of stones, sticks, stumps, or other deleterious matter one inch in diameter or larger. It shall also be free from wire, plaster, construction debris, or similar objects that would be a hindrance to planting or maintenance.



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2. The Architect shall approve suitability of soil of the site after reviewing results of the soil test.
- B. Import Top Soil: Clean, fertile, sandy loam soil, free of stones or other deleterious matter one inch in diameter or larger. It shall also be free of pockets of coarse sand, noxious weeds, sticks, lumber, brush and other litter. It shall not be infested with nematodes or other undesirable disease-causing organisms such as insects and plant pathogens. Import top soil must conform to the following:
1. Particle size
    - a. Class      Particle Size      Maximum %      Minimum %
    - b. Coarse sand      0.5 - 2.0mm      15      0
    - c. Silt plus clay      <0.05mm      50      15
    - d. Other classes:
    - e. Gravel      2-13mm      15      0
    - f. Rock 1/2 - 1"      5% by volume with none > 1"
  2. Chemistry
    - a. Salinity: Saturation Extract Conductivity (ECe) - less than 3.0 sD/m @ 25° C
    - b. Sodium: Sodium Absorption Ratio (SAR) - less than 6.0
    - c. Boron: Saturation Extract Concentration - Less than 1.0 ppm
    - d. Reaction: pH of Saturated Paste - 5.5-7.8 without high lime content
  3. Soil shall contain sufficient quantities of available nitrogen, phosphorus, potassium, calcium and magnesium to support normal plant growth. In the event of nutrient inadequacies, provisions shall be made to add required material prior to planting.
  4. In order to insure conformance, samples of the import soil shall be submitted to an approved laboratory for analysis prior to and following backfilling.
  5. Obtain imported topsoil from approved local sources.

## 2.2 SOIL AMENDMENTS

- A. Soil amendments shall be as required by Soils Test.
- B. Contractor shall provide amendments recommended by Soils Report at no additional cost to Owner, including recommendations for the quality of organic amendment.
- C. Mycorrhizal fungi shall be added in all planting areas, regardless of Soils Report. Mycorrhizal inoculum consists of a combination of :
  1. Inoculum shall contain a blend of eight top types of Endospores: *Glomus aggregatum*, *G. clarum*, *G. deserticola*, *G. intraradices*, *G. monosporus*, *G. mosseae*, *Gigaspora margarita*, and *Paraglomus brasilianum*, and seven top types of Ecto fungi spores: *Laccaria laccata*, *Pisolithus tinctorius*, *Rhizopogon amylopogon*, *R. fulvicleba*, *R. rubescens*, *R. villosuli*, and *Scleroderma* spp. The guaranteed Endo spore count shall be a minimum 50 spores/cc, and the Ecto spore count shall be a minimum 50,000 spores/cc
  2. Manufacturers:
    - a. BioOrganics Mycorrhizae Inoculants, (888) 332-7676
    - b. Mycorrhizal Applications, Inc, (866) 476-7800
    - c. Or equal.



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2.3 PLANT TABLETS

- A. 7-gram planting tablet designed for 12 month slow release. 12-8-8 NPK, 20% humus, 4% humic acids, 3.5% sulfur, 2% iron, micronutrients.

2.4 PLANT MATERIAL:

- A. Plants shall be in conformance with the California State Department of Agriculture's regulation for nursery inspections, rules, and ratings. Plants shall be healthy, vigorous, and free of insect infestations, plant diseases, sunscalds, frostburns, abrasions, or other disfigurement. Plants shall be grown in climatic conditions similar to that of the planting site, and well hardened off. Plants shall have vigorous fibrous root systems which are not rootbound or potbound. The Architect is the sole judge as to acceptability of plant material.
- B. The size of the plants will correspond with that normally expected for species and variety of commercially available nursery stock or as specified on Drawings.
- C. The Architect shall approve plant material prior to planting. Plants shall be subject to review and approval of Architect at place of growth or upon delivery for conformity to specifications, and for injury, insect infestation, and trees and shrubs for improper pruning. Such approval shall not impair the right of review and rejection during progress of the work. Architect reserves the right to refuse review if, in his/her judgment, a sufficient quantity of plants is not available for review.
- D. Plants not conforming to the requirements herein specified shall be considered defective, and such plants, whether in place or not, shall be marked as rejected and immediately removed from the site and replaced with new plants at the Contractor's expense.
- E. Plant material shall be true to botanical and common name and variety as specified in "Sunset Western Garden Book."
- F. Substitute plant material will not be permitted unless specifically approved in writing by the Architect.

2.5 GUYING AND STAKING MATERIALS:

- A. Wood tree stakes: Lodgepole pine, fully treated with CuNap, ACQ or other non-arsenic wood preservative. Do not use split stakes.
  - 1. 24" box trees and smaller: 2" (nom.) diameter by 10' long.
  - 2. 36" box trees: 3" (nom.) diameter by 12' long.
- B. Pipe tree stakes: Schedule 40 steel pipe, 1-1/2" diameter with cap, primed and painted before installation with two coats flat black exterior enamel. Touch up in field to match shop condition.
- C. Tree Ties:



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1. Flexible vinyl tree ties meeting ASTM-D-412 standards for tensile and elongation strength. Material shall be black.
2. Each tie shall be a single piece, not multiple ties joined together.
3. Manufacturers: VIT Cinch Tie, VIT Cinch Belt (larger trees), Villa Root Barrier E-Z Band, or equal.

D. Guying Hardware:

1. Wire: Pliable 1/8" galvanized steel cable.
2. Hose: 1/2" new black rubber hose.
3. Turnbuckles: galvanized or dip-painted, size as required.
4. Cable clamps: galvanized, size as required.
5. Safety Sleeve: 1/2" white PVC full length of wire.
6. Steel Guy Anchor: Duckbill Anchor by Foresight Products (800) 325-5360; Platypus Tree Anchoring Systems (866) 752-8478, or equal. Size as needed.

2.6 WATER:

- A. Furnished by Owner.
- B. Transport by Contractor as required.

2.7 MULCH:

A. Decorative Bark:

1. Walk-On-Bark as supplied by Sequoia Forest Products, telephone: (559) 591-1177.
2. Small Bark product #083 by Kellogg Supply, Inc., telephone: (310) 830-2200.
3. Small Deco Bark by Aguinaga Fertilizer Company, (949) 786-9558.

B. Composted, shredded tree trimmings:

1. Forest Floor 0-2" by Aguinaga Fertilizer Company, (949) 786-9558.

C. Submit mulch samples for approval by Architect. No shredded lumber products will be accepted.

D. D.G. to be used for pathways and non-vehicular areas may be 1/4" minus sieve size.

E. Crushed aggregate screenings shall be free from clay lumps, vegetative matter and deleterious material.

F. See Drawings for D.G. color specification.

2.8 METAL EDGING:

A. Steel edging shall be 3/16" x 5 1/2", black color, with 18" steel stake.

1. Manufacturer: Sure-Loc. (800) 787-3562.



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2.9 DRAINAGE MATERIAL

- A. 3/8" crushed rock:
  - 1. 95% -100% passing through a 3/8" screen.
  - 2. 0-5% passing through No. 8 mesh.
  - 3. 80-100# per cubic yard.

2.10 SOIL SEPARATOR:

- A. Nonwoven polypropylene fabric, needle-punched, with UV Resistance of 70%, AOS of 70 US Standard sieve, water flow rate of 110 gpm/ft<sup>2</sup>.
  - 1. Geotex 701, manufactured by Propex, or equal.

2.11 EROSION CONTROL FABRICS

- A. Jute mesh.
  - 1. Specification    Test Method    Typical Values
    - a. Yarn Fiber: Woven jute, undyed and unbleached
    - b. Yarn Count, Warp: 78 per width, minimum
    - c. Yarn Count, Weft: 42 per linear yard, minimum
    - d. Color: Natural(Brown, Earth Tone)
    - e. Fabric Width (in): 48
    - f. Fabric Weight (lb/yd<sup>2</sup>): 92
    - g. Strands/ft, Warp: 19.5
    - h. Strands/ft, Weft: 14.0
    - i. Mass/Unit Area (oz/yd<sup>2</sup>): 14.7
    - j. Wide Width Tensile, Dry (lb/ft)
    - k. Warp x Fill        ASTM D 4595    300 x 175
    - l. Wide Width Tensile, Wet (lb/ft)
    - m. Warp x Fill        ASTM D 4595    125 x 65
    - n. Elongation at Break (%): 10 x 10
    - o. Open Area (%): 60 - 65
    - p. Durability(yr): 1 - 2
    - q. Water Velocity (ft/sec): 8
    - r. Unit Shear Test (lb/ft<sup>2</sup>): 0.45
    - s. "C" Factor, 1.5:1 slope, 0.005

2.12 WEED CONTROL FABRIC

- A. Spun-bonded polypropylene with UV inhibitors, non-degrading geotextile fabric that blocks 95% of weed growth and is permeable to air, water, gasses and fertilizer. Typar 3301 or equal.
- B. Properties:
  - 1. Unit Weight: 3.0 oz/yds<sup>2</sup>
  - 2. Tensile Strength: 135 pounds
  - 3. Puncture Strength: 35 pounds
  - 4. Air Opening Size: 60/70 equivalent sieve
  - 5. Elongation at Break: <70%



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6. Trap Tear: 50 pounds
7. Flux: 70 gal/ft<sup>2</sup>/min
8. Permittivity: 1.2 sec-2
9. Color: Black

## 2.13 ROOT BARRIER

- A. Polyethylene (0.08 inch thick) or polypropylene (2.032 - 2.16 mm thick), with self-locking joiners, ½" raised 90 degree molded root deflecting ribs, ground lock tabs, double top edge, UV inhibitors. Use 24" barrier unless otherwise stated.

## 2.14 DRAIN PIPE:

- A. Sub-Surface perforated or non-perforated as indicated on Plans, size and type noted, manufactured by Lasco, National Diversified Sales (NDS) or Advanced Drainage Systems, Inc. Perforated pipe shall be completely wrapped with a water permeable nylon screen that is lapped and welded around the pipe, and surrounded by minimum 4" thickness of gravel, unless otherwise noted on Plans.
- B. Planter Area Drainpipe and Fixtures: National Diversified Sales (NDS) SDR 35 fittings and SDR 35 drain pipes with specified grates, color black, and size and type per plan. NDS, Newbury Park, California, telephone: (800) 726-1994.

## 2.15 SIPHON DEVICE / DRAIN CLEANOUT

- A. Construct PVC assemblies per drawings.

## 2.16 EPS WEIGHT REDUCER

- A. Weight Reducer: Expanded Polystyrene (EPS) #1 density Atlas EPS 'Elevation' Geofoam; STM D6817, Minimum density 0.70, Minimum compression PSI 1% deform. Cut to size as required. Available from ATLAS EPS; 800/626-9942.

# PART 3 - EXECUTION

## 3.1 INSPECTION AND PREPARATION:

- A. Site acceptance:
  1. The Contractor shall be responsible for coordinating his work with the General Contractor and other Sub-Contractors so no damage occurs to plantings after installation.
  2. The Contractor shall be responsible for verifying grades and site conditions before beginning work. No change in Contract price will be owed for actual or claimed discrepancy between existing grade and those shown on the plan after Contractor has accepted existing grades and moved on the site.



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- B. Scheduling: Perform planting only when weather and soil conditions are suitable, as approved by Architect.
- C. The irrigation system shall be operational and approved prior to planting.
- D. Utilities: Prior to excavation for planting or installation of stakes or guys, Contractor shall locate utility lines and cables, so that proper precautions will be taken not to damage them. In the event of a conflict between utility lines and plant locations, promptly notify the Architect, who shall arrange for the relocation of one or the other. Failure to follow this procedure shall make the Contractor responsible for repairing damages at his own expense.

3.2 SOIL PREPARATION:

- A. Planting Areas:
  - 1. Uniformly spread amendments and thoroughly cultivate by means of mechanical tiller per Soils Report.
  - 2. Use nutrients recommended in the Soil Report.
  - 3. Add the appropriate Mycorrhizal inoculum and incorporate at manufacturer's recommended rate.
  - 4. Perform soil preparation after irrigation is installed and tested, and prior to planting.
- B. Final Grades and Planting Area Layout:
  - 1. At time of planting, the top two (2) inches of areas to be planted or seeded shall be free of stones, sticks, stumps, or other deleterious matter one inch in diameter or larger. It shall also be free from wire, plaster, construction debris, or similar objects that would be a hindrance to planting or maintenance.
  - 2. Contractor shall be responsible for shaping planting areas as indicated on Plans or as directed by Architect.
  - 3. Minor modifications to grade may be required to establish the final grade. Remove soil generated by excavations to an approved off-site location unless said soil can be utilized to obtain desired grade.
  - 4. Finish grading shall insure proper drainage of the site as determined by the Architect.
  - 5. Areas shall be graded so that the final grades will be 1-1/2" below adjacent paved areas, sidewalks, valve boxes, headers, cleanouts, drains, manholes, etc. or as indicated on Plans.
  - 6. Surface drainage shall be away from building foundations.
  - 7. Eliminate erosion scars prior to commencing maintenance period. Depressions due to settling shall be eliminated before and after planting.
  - 8. Slopes of two to one (2:1) or steeper shall be protected with erosion control fabric. Contractor shall request clarification from Architect for fabric and methods.
- C. Compacted Soil / Percolation Testing: Soil may be heavily compacted which can hinder root development, drainage and aeration.
  - 1. Severely compacted areas shall be ripped or tilled to a depth of at least 9" prior to planting.



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2. Percolation tests of water through the soil shall be performed where trees 24" box size and larger are proposed. If trees are to be planted over a large area, several percolation tests will be required.
    - a. Excavate two planting pits 24" deep by 2 times rootball diameter. Install sand filled drainage sump as specified in 3.3.D.4, below, in one of the pits.
    - b. Fill the pits with water and allow to drain completely.
    - c. Fill the pits with water a second time.
    - d. Results:
      - 1) If the pit with no sump drains completely within 24 hours, no drain sump is necessary for trees planted within the vicinity of the test pit.
      - 2) If the pit with no sump does not drain completely within 24 hours, but the pit with the sump does, sumps are required for trees planted in the vicinity of the test pit.
      - 3) If the pit with the sump does not drain completely within 24 hours, advise the Owner prior to planting.
- D. Pre-Plant weed Control:
1. "Grow & Kill": If weeds exist on site at the beginning of work, spray with a non-selective systemic contact herbicide, recommended by an approved licensed landscape Pest Control Advisor and applied by a licensed Pest Control Operator. Leave sprayed plants intact to allow systemic kill as directed by Advisor. After recommended kill period, water thoroughly to encourage new weed growth, and re-apply systemic herbicide.
  2. Treat planting areas, except for those to be seeded, with pre-emergent herbicide, recommended by an approved licensed landscape Pest Control Advisor and applied by a licensed Pest Control Operator
  3. Maintain site weed free until final acceptance by Owner by utilizing mechanical, manual, or chemical treatment.
- E. Slope Stabilization
1. Slopes greater than 3:1 are to be stabilized with jute mesh.
  2. Prepare soil as noted above.
  3. Unroll jute from top of slope to bottom. Secure at top of slope by toeing jute in 6" deep. Reinforce with a row of at least five staples, spacing each about a foot apart, and covering with soil.
  4. Place staples 18" to 24" apart throughout to secure matting to ground. Staples must be driven flush with soil surface.
  5. Overlap edges of rolls 6", minimum. Securely staple the two layers to the ground.
  6. Install jute mesh loosely - do not stretch.
  7. Check slots may be needed on steep slopes to prevent subsurface erosion.
    - a. Dig 6" deep trench perpendicular to water flow.
    - b. Drop two or three folds of fabric in the slot.
    - c. Staple fabric securely in bottom of trench, and continue rolling down hill.
  8. Use approximately 200 staples per 100 square yards of fabric.



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### 3.3 PLANTING

- A. Planting Layout: Plant layout is to be approved by Architect before planting begins. Layout of trees and major plantings shall be approved first. One tree with each type of specified staking shall be approved prior to planting of trees. Bring conflicts regarding the exact locations of plant pits to the attention of Owner's representative and Architect. If underground utility lines or other unknowns are encountered in excavation for planting, alternate locations for planting may be selected by the Architect. It is the Contractor's responsibility to verify with the Owner's superintendent and governing agencies the location and depth of underground utilities.
- B. Planting of Trees and Shrubs:
1. Do not plant rootbound, dried out, undersized, or damaged plants.
  2. Install trees, shrubs, and groundcovers before planting seed or sod.
  3. Excavated holes shall have vertical sides with roughened surfaces and shall be twice the diameter and the depth of the root b.
  4. Drainage: Drainage sumps are to be provided in each tree pit. Drain sumps (12-inch diameter by 6 feet deep) may be augured. Sump is to be filled with coarse sand. Planting may proceed after sump installation.
  5. Fill excavations with water and allow to percolate out, before positioning trees and shrubs.
  6. Install root control barriers where indicated on Plans and where site conditions (trees within three feet of pavement) dictate. Install per manufacturer's instructions.
  7. Center plant in pit or trench. Remove boxes and cans without damage to rootball. Add the appropriate Mycorrhizal inoculum next to rootball at manufacturer's recommended rate. Set plant plumb and hold rigidly in position until soil has been dampened firmly around b or roots. An earthen basin shall be constructed around each plant. Each basin shall be of a depth sufficient to hold at least two inches (2") of water. Remove basin in turf areas after initial watering. Plants that settle deeper than the surrounding grade shall be raised to surrounding grade level.
- C. Planting Tablets: Place the following numbers of 7-gram planting tablets within the backfill of each plant:
- | Container size / Number of tablets |    |
|------------------------------------|----|
| 1 gallon                           | 3  |
| 5 gallon                           | 8  |
| 15 gallon                          | 12 |
| 24" box                            | 16 |
| 36" box                            | 24 |
| 48" box                            | 32 |
- D. Staking and Guying: Staking and Guying of trees shall be completed immediately upon planting. Stakes shall be installed plumb and as indicated in details. Guy locations and methods shall be reviewed prior to planting of boxed trees. Bring conflicts of locating guys or stakes to the attention of Architect. Remove nursery stakes when site stakes have been installed.



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- E. Ground covers: Ground covers or seedlings shall be planted in straight rows and evenly spaced, unless otherwise noted, and at intervals called out in the drawing. Triangular spacing shall be used unless otherwise noted on the drawing. Fill in bare areas with plants at the required spacing. Damage to plants by trampling or other work in this contract shall be repaired immediately.
- F. Mulch covers:
  - 1. Complete planting and finish grades before placing mulch.
  - 2. Place mulch material in a continuous layer 3" deep adjacent to plant crown in shrub and groundcover areas, and in areas between shrubs.
  - 3. Place mulch in a 3" deep layer in areas with flatted groundcover and annual color.
  - 4. Install dg mulch over weed control fabric.
    - a. Overlap fabric a minimum of 8".

#### 3.4 CLEANUP

- A. After planting operations have been completed, remove trash, excess soil, empty plant containers, and rubbish from the property, and dispose of legally.
- B. Cleanup shall be performed at the end of each working day, with a maximum cleanup effort (in a manner satisfactory to the Owner) for each weekend or Holiday.
- C. The Contractor shall sweep the site and shall wash down pavement within the Contract area, leaving the premises in a clean condition.
- D. Walks shall be left in a clean and safe condition.
- E. Scars, ruts, or other marks in the ground caused by this work shall be repaired and the ground left in a smooth condition throughout the site.

END OF SECTION



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SECTION 32 91 13 - SOIL PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. In-Place Amendment of Planting Area Soil Surfaces.
  - 2. Plant Pit Backfill Mix.
- B. Related Sections:
  - 1. Section 32 01 30, Maintenance and Operations of Site Improvements
  - 2. Section 32 84 00, Planting Irrigation.
  - 3. Section 32 93 00, Landscape Planting.

1.2 REFERENCES

- A. ASTM — ASTM International: D 1557 — Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
- B. USDA — United States Department of Agriculture:
  - 1. Soil Texture Triangle Classification.
  - 2. Handbook No. 60.

1.3 DEFINITIONS

- A. Acceptance, Acceptable, or Accepted: Acceptance by the Landscape Architect in writing.
- B. Excessive Compaction: Planting area soil compaction greater than 75 percent of maximum dry density as determined by ASTM D 1557.
- C. Landscape Architect: Landscape Architect employed by the Owner to provide professional landscape architectural services for the Project.
- D. Drip Line: Line straight down from outermost limit of tree canopy branching.

1.4 SYSTEM DESCRIPTION

- A. Backfill Mixes and Amended Planting Area Surface Soil: Uncompacted on-site soil with amendments incorporated uniformly to provide a well-draining, fertile medium for vigorous plant root growth.



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- B. Soil Mixes: Uncompacted, imported topsoil with amendment incorporated uniformly to provide a well-draining, fertile medium for vigorous plant root growth.

## 1.5 SUBMITTALS

- A. General Requirements: Refer to Division 1.
- B. Product Data:
  - 1. Chemical Amendments.
  - 2. Organic Soil Conditioner.
  - 3. Fertilizers.
  - 4. Polymeric Soil Conditioner.
  - 5. Organic Amendment.
  - 6. Coco Peat.
- C. Test Reports:
  - 1. Laboratory soil test reports indicating specified characteristics of soil, with test date no more than 2 weeks old.
  - 2. Laboratory soil test reports.
  - 3. Laboratory test report of organic amendment indicating specified characteristics of organic amendment, with test date no more than 2 weeks old.
  - 4. Sieve analysis of sand for sodded lawn planting mix with test date no more than 2 weeks old.
- D. Purchase Documentation:
  - 1. Fertilizer Purchase and Delivery Invoices.
  - 2. Chemical Amendment Purchase and Delivery Invoices.

## 1.6 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
  - 1. Meet requirements of applicable laws, codes, and regulations required by authorities having jurisdiction over Work.
  - 2. Provide for inspections and permits required by federal, state and local authorities in furnishing, transporting, and installing materials.
- B. Agronomic Testing Agency:
  - 1. Send samples to Wallace Laboratories, 365 Coral Circle, El Segundo, CA 90245, or approved equal, and employ the laboratory to test the soil mixes and import soils.
- C. Settlement Mock-Up:



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1. Mock-up areas of backfill mix at the specified depths and apply irrigation to induce settlement, to help determine the amount of settlement which will be caused by irrigation and rain.
2. Use settlement observed in mock-up to help determine allowances to make for settlement as required by this Section and other Sections.

## 1.7 SITE CONDITIONS

- A. Environmental Requirements:
  1. Do not work soil when moisture content is so great that excessive compaction will occur, nor when it is so dry that dust will form in the air or that clods will not break readily.
  2. Apply water, if necessary, to bring soil to an optimum moisture content for tilling.
  3. Do not work soil when muddy or frozen.
  4. Do not apply chemicals if wind conditions will cause hazardous drift to people or property.
- B. Existing Conditions:
  1. Prior to Work commencement review and clearly mark in field horizontal and vertical locations of existing public underground utilities and structures with respective utility companies.
  2. Prior to Work commencement review and clearly mark in field horizontal and vertical locations of existing private underground utilities and structures with the Owner's Designated Representative.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS AND SUPPLIERS

- A. Fertilizers:
  1. Roots, Inc., Independence, Mo.; (800) 342-6173; [www.rootsinc.com](http://www.rootsinc.com).
  2. Vermi Technology Unlimited, Orange Lake, Fla; (352) 591-1111; [www.vermitechnology.com](http://www.vermitechnology.com).
  3. Kelly's Green Team, Newark, Mo.; (660) 627-5500; [www.kellysgreenteam.com](http://www.kellysgreenteam.com).
- B. Organic Amendments:
  1. Earthworks Soil Amendments Inc.; (951) 782-0260; <http://www.ewsa.com>.
  2. Aguinaga Green, Inc.; (949) 786-9558; <http://www.aguinagagreen.com>.

### 2.2 MATERIALS

- A. Import Top Soil: Import top soil shall be classified as sandy loam, and must conform to the following:



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1. Particle size

Class	Particle Size Range	Maximum %	Minimum %
Coarse sand	0.5 - 2.0mm	15	0
Silt plus clay	<0.05mm	50	15

Other classes:

Gravel	2-13mm	15	0
Rock	1/2 – 1 inch	5 percent by volume with none > 1 inch	
2. Chemistry
  - a. Salinity: Saturation Extract Conductivity (ECe) - less than 3.0 sD/m @ 25° C
  - b. Sodium: Sodium Absorption Ratio (SAR) - less than 6.0
  - c. Boron: Saturation Extract Concentration - Less than 1.0 ppm
  - d. Reaction: pH of Saturated Paste - 5.5-7.8 without high lime content
3. Soil shall contain enough available nitrogen, phosphorus, potassium, calcium and magnesium to support normal plant grown. In the event of nutrient inadequacies, provisions shall be made to add required material prior to planting.
4. In order to insure conformance, samples of the import soil shall be submitted to an approved laboratory for analysis prior to and following backfilling.
5. Obtain imported topsoil from approved local sources.

B. Organic Amendment:

1. Fully composted aerobic humus compost without presence of decomposition products. The organic matter content shall be at least 50% on a dry weight basis. Humus material shall have an acid-soluble ash content of no less than 6% percent and no more than 20 percent.
2. The pH of the material shall be between 6 and 7.5.
3. The salt content shall be less than 10 millimho/cm at 25 degrees C on a saturated paste extract.
4. Boron content of the saturated extract shall be less than 1.0 part per million
5. Silicon content (acid-insoluble ash) shall be less than 50 percent.
6. Calcium carbonate shall not be present if the amendment is to be applied on alkaline soils.
7. Types of acceptable products are composts, manures, mushroom composts, straw, alfalfa, peat mosses, etc., low in salts, low in heavy metals, free from weed seeds, free of pathogens and other deleterious materials.
8. Composted wood products are conditionally acceptable (stable humus must be present). Wood-based products are not acceptable which are based on redwood or cedar.
9. Sludge-based materials are not acceptable.
10. Carbon-nitrogen ratio shall be less than 25:1.
11. The compost shall be aerobic without malodorous presence of decomposition products.



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12. The maximum particle size shall be 0.5-inch and 80 percent or more shall pass a No. 4 screen for mixing with soil. The maximum particle size for applying via hydroseeding machine shall be 0.25-inch.
13. Maximum total permissible pollutant concentrations in organic amendment in parts per million on a dry-weight basis:

Arsenic:	20
Cadmium:	15
Chromium:	300
Cobalt:	50
Copper:	100
Lead:	200
Mercury:	10
Molybdenum	20
:	
Nickel:	100
Selenium:	50
Silver:	10
Vanadium:	50
Zinc:	200

Higher amounts of salinity or boron may be present if the soils are to be pre-leached to reduce the excess or if the plant species will tolerate the salinity and/or boron.

14. From 45- to 65-percent moisture measured via wet-weight basis.
15. Free of stones and debris.
16. Tests 5 to 8 on Solvita Test.

C. Fertilizers:

1. Roots "M-Roots" with mycorrhiza 3-3-3.
2. Kelley's Green Team Gypsum Fairway Pellets, 76-percent calcium sulphate dehydrate, 17-percent calcium; 14-percent sulphur, derived from mined gypsum, less than 1-percent moisture content.
3. Vermi Technology pure black worm castings produced without waste products; free of larva, sticks, stones, and debris; 48 percent by weight minimum organic content per ASTM D2974; complying with the following:

Item	Criteria
-----	
Total Ash	48 percent to 52 percent
pH:	5.0 to 7.5
% Moisture (wet wt. basis:	30 percent to 50 percent
Solvita Rating:	> 8



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- D. Potential Chemical Amendments Required by Accepted Amendment Program and Backfill Mix:
1. Ground Limestone: Agricultural limestone containing not less than 85 percent of total carbonate, ground to such fineness that 50 percent will pass No. 1 sieve and 90 percent will pass No. 20 sieve.
  2. Dolomite Lime: Agricultural grade mineral soil conditioner containing 35 percent minimum magnesium carbonate and 49 percent minimum calcium carbonate, 100 percent passing No. 65 sieve.
  3. Gypsum: Agricultural grade product containing 80 percent minimum calcium sulfate.
  4. Iron Sulfate (Ferric or Ferrous): Supplied by a commercial fertilizer supplier, containing 20 to 30 percent iron and 35 percent to 40 percent sulfur.
  5. Sulfate of Potash: Agricultural grade containing 50 to 53 percent of water-soluble potash.
  6. Single Superphosphate: Commercial product containing 20 to 25 percent available phosphoric acid.
  7. Ammonium Sulfate: Commercial product containing approximately 21 percent ammonia.
  8. Ammonium Nitrate: Commercial product containing approximately 34 percent ammonia.
  9. Calcium Nitrate: Agricultural grade containing 15-1/2 percent nitrogen.
  10. Urea Formaldehyde: Granular commercial product containing 38 percent nitrogen.
  11. IBDU (Iso Butyldiene Diurea): Commercial product containing 31 percent nitrogen.
  12. Soil Sulfur: Agricultural grade sulfur containing a minimum of 96 percent sulfur.
  13. Silicic Acid Calcium: Commercial grade.
- E. Polymeric Soil Conditioner: Twenty to 25 percent anionic polyacrylamide, water-soluble, linear, 7,500,000-dalton, soil aggregating polymer containing a minimum of 20,000 soil binding sites proven to be efficacious.
- F. Soil Reinforcement Fiber for Stabilized, Civic Green Lawn Mix: Stalok Fiber G-400 as available from Stabilizer Solutions, Phoenix, AZ; (800) 336-2488; [www.stabilizersolutions.com](http://www.stabilizersolutions.com).

## 2.3 MIXES

- A. Preliminary Plant Pit Backfill and Shrub Import Profile Mix to Establish Bid (actual quantities contingent on amendment program determined by the soil test report):
1. Content:
    - a. 8 cubic feet of organic amendment per cubic yard of dry import top soil.
    - b. 1-pound dry polymeric soil conditioner per cubic yard of dry soil.
    - c. 1/2-pound Triple Superphosphate 0-45-0 per cubic yard of dry soil.



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- d. 1-pound of Nitroform 38-0-0 per cubic yard dry soil.
  - e. 1-pound of Potassium Sulfate 0-0-50 per cubic yard dry soil.
  - f. 2-pound of Gypsum per cubic yard dry soil.
- 2. Mixing:
  - a. Blend materials uniformly with 50 percent dry existing soil excavated from plant pits and 50 percent dry imported topsoil in bulk by turning over materials with an end loader.
  - b. Blend materials in a clean area which will not contaminate mix.
  - c. Do not mix in planting areas.
- B. Final Plant Pit Backfill Mix for Installation: Backfill mixes determined by the soil test report.
- C. Preliminary In-Place Amendment of Planting Area Surfaces to Establish Bid (actual quantities contingent on amendment program determined by the soil test report):
  - 1. Rip existing soil to a depth of 9 inches and homogeneously incorporate the following amendments to a 6 inches depth (rates are per 1,000 square feet):
    - a. Ammonium Sulfate (21-0-0) – 5 lbs.
    - b. Potassium Sulfate (0-0-50) - 5 lbs.
    - c. Triple Superphosphate (0-45-0) – 5 lbs.
    - d. Agricultural gypsum – 15 lbs.
    - e. High quality soil amendment – 3 cubic yards.
- D. Final In-Place Amendment of Planting Area Surfaces: Determined by the soil test report.

## 2.4 SOURCE QUALITY CONTROL

- A. Organic Amendment: Employ independent soil testing laboratory to test organic amendment for specified properties and submit test results.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. General: Examine site and verify that conditions are suitable to receive Work and that no defects or errors are present which would cause defective installation of products or cause latent defects in workmanship and function.
- B. Subgrade:
  - 1. Verify that the subgrade is at the correct elevation and slope.
  - 2. Inspect soil surface for sticks, oils, chemicals, plaster, concrete, and other deleterious materials.



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3. Remove deleterious materials.
- C. Underground Utilities and Structures: Verify that the locations of utilities, structures and other underground items have been clearly marked.
- D. Notification of Unsuitable Conditions: Before proceeding with Work, notify the Owner's Designated Representative in writing of unsuitable conditions and conflicts.
- E. Soil Tests to Determine Final Plant Pit Backfill Mix, Planting Area Soil Surface Amendment Programs, and Maintenance Period Fertilization Programs:
  1. Take fifteen 1-pound composite representative soil samples from locations determined by the Landscape Architect in the field.
  2. Send samples to Wallace Laboratories, 365 Coral Circle, El Segundo, CA 90245, or approved equal, and employ the laboratory to test the soil samples for the following:
    - a. pH measurement in the saturation extract per USDA Handbook No. 60, Method 21.
    - b. Electrical conductivity of the saturation extract per USDA Handbook No. 60, Method 2.
    - c. Sodium absorption ratio of the saturation extract per USDA Handbook No. 60, Method 20b.
    - d. Determination of boron, calcium, copper, iron, magnesium, manganese, molybdenum, phosphorous, potassium, sodium, sulfur, and zinc, via the following test methods: Mehlich Number 3, Bray P1, Bray P2, Olsen P, DTPA, ammonium acetate, ammonium bicarbonate DTPA, and hot water extract from boron.
    - e. Analysis of saturation extract for calcium, magnesium, sodium, boron, chloride, phosphorous, nitrate, and sulfate.
    - f. Measurement of following trace metals by the DTPA extract: aluminum, arsenic, cadmium, chromium, cobalt, lead, lithium, nickel, selenium, silver, strontium, tin, and vanadium.
    - g. Presence of calcium carbonate and magnesium carbonate.
    - h. Estimate of soil texture per commonly used methods.
    - i. Estimate of organic matter content per commonly used methods.
    - j. Exchangeable Ammonium Cation.
    - k. Base Saturation.
    - l. Cation Exchange Capacity.
    - m. Carbonates Determination.
    - n. Soil Bulk Density.
    - o. Water Infiltration Rate per USDA Handbook No. 60, Method 34b.
  3. At least 30 days prior to commencement of soil preparation Work, submit to the Landscape Architect the laboratory's written soil test report including the laboratory's soil test data; the laboratory's interpretation of nutritional



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deficiencies, excesses, and potential toxicities; the laboratory's amendment recommendations; and the laboratory's maintenance recommendations.

F. Soil Tests for Parasitic Nematodes:

1. Test soils which have been used for agricultural purposes within the prior 12 months for parasitic nematodes.
2. Soil will be acceptable if the parasitic nematode population is less than 200 per 50 cubic centimeters of soil.
3. Do not artificially dry soil prior to testing.
4. Submit written test report to the Architect/Engineer and Horticultural Consultant.

G. Soil Tests for Herbicide Contamination:

1. Perform a radish/rye grass growth trial on soils suspected of herbicide contamination.
2. Submit written test report to the Architect/Engineer and Horticultural Consultant.

3.2 WEED ERADICATION PROGRAM OF EXISTING VEGETATION AT PLANTING AREAS

- A. Six weeks prior to planting and before tilling or amending planting areas, spray existing vegetation with 3 percent Glyphosate solution and repeat treatment 3 weeks later to kill re-emerging vegetation.

3.3 PREPARATION OF SUBGRADE TO RECEIVE IMPORTED SOIL MIXES

A. Protection:

1. Use every possible precaution to prevent damage to existing conditions to remain such as structures, utilities, irrigation systems, plant materials and paving on or adjacent to the site of the Work.
2. Use every possible precaution to prevent excessive compaction of planting area soil within or adjacent to the areas of Work.
3. Provide barricades, fences or other barriers to protect existing conditions to remain from damage and excessive compaction during construction.
4. Do not store materials or equipment, permit burning, or operate or park equipment under the branches of existing plants to remain.
5. Submit written notification of conditions damaged during construction to the Owner's Designated Representative immediately.

B. Ripping Subgrade Soil:

1. Prior to placing topsoil, rip areas to receive topsoil on the same day topsoil is placed.
2. Rip subgrade twice to a depth of 6 inches unless indicated otherwise.
3. Space ripping tines at 24 inches on center.
4. Make second ripping pass in a direction 90 degrees to the direction of the first ripping pass.



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5. Do not rip closer than 2 feet horizontally and vertically to installed and existing utility lines and structures.
- C. Location and Depths: As indicated on the Drawings.
- D. Mix Placement:
1. Place soil mixes same day that subgrade soil ripping occurs and prior to vehicle or equipment traffic running over the ripped surface.
  2. Place soil mixes with equipment of appropriate size for area and in a manner that avoids excessive compaction of the topsoil.
  3. Avoid repeatedly driving equipment in same tracks so that topsoil does not become excessively compacted.
- E. Allowances: Place topsoil to elevations that allow for settlement, addition of soil amendment, and finish grading tolerances.
- F. Finished Grade: See Section 32 91 19.
- G. Surface Drainage: Keep soil surface sloped so that surface drains.
- H. Compaction and Contamination:
1. In handling materials and operating tools and equipment, protect the topsoil from excessive compaction by laying down planks, plywood, or other accepted protective devices.
  2. Do not store or stockpile materials on the topsoil.
  3. Do not allow vehicles to park or drive on topsoil, except equipment which is preparing and finish grading the soil.
  4. If ruts are formed, blade rutted topsoil smooth.
  5. Loosen excessively compacted soil to the full depth of the excessive compaction, rototill, and grade surface smooth.
- I. Excessively Compacted Topsoil:
1. Mechanically loosen excessively compacted topsoil to its full depth via a method acceptable to the Landscape Architect and re-grade surface smooth.
  2. Keep topsoil from being excessively compacted until date of Final Completion.
- J. Erosion Repair:
1. Repair erosion that occurs between topsoil installation and plant or seed installation.
  2. Fill eroded areas with topsoil and finish grade.

### 3.4 PREPARATION OF SOIL SURFACE OF PLANTING AREAS

- A. Protection of Existing Conditions:



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1. Use every possible precaution to prevent damage to existing conditions to remain such as structures, utilities, plant materials and walks on or adjacent to the site of the Work.
  2. Use every possible precaution to prevent excessive compaction of planting area soil within or adjacent to the areas of Work.
  3. Provide barricades, fences or other barriers to protect existing conditions to remain from damage during construction.
  4. Do not store materials or equipment, permit burning, or operate or park equipment under the branches of existing plants to remain.
  5. Submit written notification of damaged plants and structures to the Owner's Designated Representative immediately.
- B. Surface Preparation:
1. Inspect soil surface for sticks, oils, chemicals, plaster, concrete, and other deleterious materials.
  2. Do Work required to remove and dispose of the deleterious materials.
- C. Excessively Compacted Areas:
1. Where tilled planting soil or imported planting soils have become compacted more than 75-percent maximum dry density per ASTM D 1557 rip soil to 4 inches below the depth of the excessive compaction.
  2. Space ripping tines at 18 inches on center.

### 3.5 AMENDMENT OF SOIL SURFACE OF PLANTING AREAS

- A. Preliminary Amendment Program to Establish Bid for existing soil Areas in Planting Areas Not to Receive Topsoil: 3 cubic yards of organic amendment per 1,000 square feet, 9 pounds of Nitroform 38-0-0 per thousand square feet, and 2.5 pounds of Triple Superphosphate 0-45-0 per thousand square feet, 10 pounds of Potassium Sulfate 0-0-50 per 1,000 square feet, 20 pounds of polymeric soil conditioner per 1,000 square feet, 30 pounds of Gypsum per 1,000 square feet.
- B. Preliminary Amendment Program to Establish Bid for Areas with Imported Topsoil: 6 cubic yards of organic amendment per 1,000 square feet, 20 pounds of polymeric soil conditioner per 1,000 square feet, 20 pounds of Nitroform 38-0-0 per 1,000 square feet, 10 pounds of Potassium Sulfate 0-0-50 per 1,000 square feet, and 5 pounds of Triple Superphosphate 0-45-0 per 1,000 square feet, 30 pounds of Gypsum per 1,000 square feet.
- C. Final Amendment Programs for Installation: Determined by soil test report results.
- D. Amendment Incorporation:
1. Spread dry amendments evenly over surface of dry soil with a drop spreader.
  2. Organic amendment and soil must be dry.



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3. Incorporate amendments uniformly within top 6 to 8 inches of soil within a few hours after amendment application, except at areas within drip lines of existing trees to remain.
4. At areas within drip lines of existing trees to remain, incorporate amendments uniformly to 1 to 2-inch depth within a few hours after application.
5. Mechanically incorporate the amendments into the soil via a method that will not excessively compact the soil below incorporated amendments.
6. To activate polymeric conditioner, irrigate soil very slowly so that soil surface will not form a crust and until water penetrates 6-inch depth.
7. Allow soil to dry until stringiness disappears.
8. Prior to planting, re-till soil to a 6-inch depth at areas outside of drip lines of existing trees to remain and re-till soil to a 1 to 2-inch depth at areas within drip lines of existing trees to remain.

### 3.6 FIELD QUALITY CONTROL

A. Soil Amendment Verification:

1. Employ the same soil testing laboratory used to test the soil as indicated in Article 3.1 E of this Section, to take up to 10 random composite samples of amended soil surface areas and soil mixes for laboratory testing to verify amendment composition.
2. Perform corrective work as recommended by the laboratory soil test reports.
3. When a laboratory soil test indicates that the soil or soil mixes meet the requirements of the Specifications the Contractor will receive written notification of acceptance from the Landscape Architect.
4. Installation of ground cover plants and seed may commence upon Contractor's receipt of the written notification of acceptance.

END OF SECTION



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SECTION 32 95 00 - EXTERIOR PLANTING SUPPORT STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Wire rope trellis for vegetation.
- B. Related Sections:
  - 1. Division 32 Section(s) for vegetation being supported by trellis systems.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For trellis systems. Include fabrication and installation layouts of trellis system; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
- C. Samples: Trellis system, 12 by 12 inches, include each type of mounting attachment required for installation.

1.03 INFORMATIONAL SUBMITTALS

- A. Delegated-Design Submittal: For trellis systems indicated to comply with structural and seismic performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For trellis systems to include in operation and maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing systems similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

1.06 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with trellis system by field measurements before fabrication and indicate measurements on Shop Drawings.

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PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trellis system, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.
- B. Structural Performance: Trellis systems shall withstand the effects of gravity, vegetation, wind, rain, snow, and ice.
- C. Seismic Performance: Trellis systems, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.02 WIRE ROPE TRELLIS SYSTEM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Jakob Rope Systems; GreenGuide, or comparable product by one of the following:
  - 1. Carl Stahl DecorCable.
- B. Description: Metal rope trellis system fabricated to support vegetation for vertical application.
- C. Wire Grid Spacing: Metal wire intersections spaced as indicated on Drawings.
- D. Wire Material: Stainless Steel.
- E. Mounting Hardware: Metal brackets, anchors, and fittings for the attachment of metal wire to wall substrate.

2.03 MATERIALS

- A. Stainless Steel: ASTM A666, Type 316.
- B. Fasteners: Use types and sizes to suit unit installation conditions.
  - 1. For fastening stainless steel, use Type 316 stainless-steel fasteners.
- C. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.

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2.04 FABRICATION

- A. Fabricate trellis system to sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances.
  - 1. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install panel or wire rope support assembly at locations and with fasteners recommended by manufacturer. Use manufacturer's standard horizontal and vertical members to comply with performance requirements.
- B. Provide anchorage devices and fasteners where needed to secure to in-place construction.
- C. Perform cutting, drilling, and fitting required. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
- D. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory and refinish entire unit or provide new units.

3.02 ERECTION TOLERANCES

- A. Installation Tolerances: Align trellis system within installed tolerance of 1/4 inch in 20 feet, non-accumulative, on level, plumb, and location lines as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.03 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as units are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, clean finished surfaces as recommended by manufacturer. Maintain in a clean condition during construction.
- B. Replace trellis components that have been damaged or have deteriorated beyond successful repair.

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END OF SECTION

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SECTION 33 05 00 - INSTALLATION OF BURIED PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section includes placement of buried pipelines and connections.

1.02 RELATED WORK DESCRIBED ELSEWHERE

- A. Section 312333 - Trenching, Backfill and Compaction

1.03 SUBMITTALS

- A. Installation schedule.
- B. Product data for each type of warning tape..

PART 2 - MATERIALS

2.01 PIPE MATERIAL

- A. Refer to the section on pipe by type.

2.02 ACCESSORIES

- A. Non-Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick.
- B. Detectable Warning Tape: Provide an inert polyethylene film detectable warning tape manufactured for marking and identifying underground utilities, 6 inches wide with a minimum metallic foil core of 0.35 mils and shall be reinforced, consisting of 5 mils total thickness.
- C. Continuously inscribe warning tape with a description of the utility; colored as follows:
  - 1. Red: Electric.
  - 2. Yellow: Gas, and dangerous materials.
  - 3. Orange: Telephone and other communications.
  - 4. Blue: Water systems.
  - 5. Green: Sewer systems.
  - 6. Purple: Reclaimed Water System
- D. Detectable wire



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1. Tracer wire shall be provided when non-detectable warning tape is used for plastic piping. Insulated No. 12 copper tracer wire shall be buried with the pipe and ends brought to surface.

PART 3 - EXECUTION

3.01 DELIVERY AND TEMPORARY STORAGE OF PIPE AT SITE

- A. Limit on-site pipe storage to a maximum of one week.
- B. Avoid damage to the pipe. If necessary, provide suitable supports.

3.02 HANDLING OF PIPE

- A. Lift pipes with handling beams or wide belt slings as recommended by the pipe manufacturer. Do not use cable slings.

3.03 SANITATION OF PIPE INTERIOR

- A. During laying operations, do not place tools, clothing or other materials in the pipe.
- B. When pipe laying is not in progress, close the ends of the pipe by a vermin-proof plug constructed in a manner to deter entry by children and prevent the entrance of animals and foreign materials.

3.04 PLACEMENT OF PIPE IN TRENCH

- A. Control water in trench per Section 312333.
- B. Lay pipes uphill if the grade exceeds ten percent (10%).
- C. Where pipe bedding material is detailed below the subgrade, place and compact the bedding.
- D. Cut a depression to accommodate the pipe bell and external joint filler form and spaces to permit removal of the pipe handling slings.
- E. Lower the pipe onto the bedding and install it to line and grade along its full length of firm bearing except at the bell and at the sling depressions. The tolerance on grade is one-quarter inch (1/4"). The tolerance on line is one inch (1").
- F. Proceed to complete the pipe embedment as specified in Section 312333.
- G. The radius of curvature of the trench shall determine the maximum length of pipe section that can be used without exceeding the allowable deflection at a coupling. The deflection at any flexible joint shall not exceed that prescribed by the manufacturer of the pipe. The manufacturer's printed installation guide outlining the radii of curvature that can be negotiated with pipe sections of various lengths shall be followed.



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- H. Proper implements, tools and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the Contractor for safe and efficient execution of the work. All pipe, fittings, valves and accessories shall be carefully lowered into the trench by means of handling beams, wide belt slings or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.
- I. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, nor any other method that may fracture the pipe or will produce ragged, uneven edges.

The pipe and accessories shall be inspected for defects prior to the lowering into the trench. Any defective, damaged or unsound pipe shall be repaired or replaced. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench.

- J. When the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers or main drains, the obstruction shall be permanently supported, relocated, removed or reconstructed by the Contractor in cooperation with owners of such utility structures. Unless otherwise indicated, this work shall be performed at the Contractor's expense.

3.05 ASSEMBLING RUBBER RING JOINTS

- A. Clean the ends of the pipe to be joined of foreign material.
- B. Immediately prior to lowering each section of pipe into the trench, apply a nontoxic water soluble vegetable soap solution to the inside of the bell of the pipe in the trench and to the rubber gasket and spigot groove of the pipe to be installed. Stretch the rubber gasket into the groove of the spigot end of the pipe to be inserted and distribute it uniformly around the circumference.
- C. Without tilting the pipe to be installed, enter its spigot into the bell of the pipe in the trench. Use come-a-longs or pipe jacks to drive spigot end home horizontally. Maintain joint recess recommended by pipe manufacturer or made-up joint. Where deflections at joints are required for curved alignment, do not exceed the pipe manufacturer's recommended maximum joint opening on one side.

3.06 OPERATIONS INCIDENTAL TO JOINT COMPLETION

- A. Plan joint completion to accommodate temporary test bulkheads for hydrostatic testing.

3.07 PIPE EMBEDMENT

- A. Provide sufficient space along each side of the pipe and the trench wall per plans to observe that the embedment material fills all spaces below pipe spring line under the pipe haunches.



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- B. Start the backfilling operations specified in Section 312333 immediately after coating the field joints.

3.08 PIPELINE CLOSURE ASSEMBLIES

- A. Employ pipeline closure assemblies to unite sections of pipeline laid from opposite directions and to adjust the field length of the pipeline to meet structures, other pipelines, and points established by design stations.

3.09 FLANGED CONNECTIONS

- A. Lubricate nuts and bolts with oil or graphite prior to installation.
- B. Coat flanges and non-stainless-steel bolts with bitumen as specified.
- C. Wrap flanges which connect with buried valves or other equipment with two layers of polyethylene film specified for the valves and equipment. Extend the wrap over the flanges and bolts and secure it around the adjacent pipe circumference with tape.

END OF SECTION



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SECTION 330513 - MANHOLES AND STRUCTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Monolithic concrete manholes with masonry transition to lid frame, covers, anchorage, and accessories.
- B. Modular precast concrete manhole sections with tongue-and-groove joints with masonry transition to lid frame, covers, anchorage, and accessories.
- C. Monolithic FRP manholes with transition to lid frame, covers, anchorage, and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 32 13 13 – Sitework Concrete.

1.03 REFERENCE STANDARDS

- A. ASTM A48/A48M - Standard Specification for Gray Iron Castings 2003 (Reapproved 2016).
- B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- C. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete 2017.
- D. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete 2010a (Reapproved 2016).
- E. ASTM C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections 2018.
- F. ASTM C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections (Metric) 2018.
- G. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals 2018.



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- H. ASTM C923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals (Metric) 2018.
- I. ASTM D3753 - Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Manholes W:\1P2S011500\ENGR\EXHIB\PDF\2020-0515and Wetwells 2019.

#### 1.04 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures.
- B. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions.
- C. Shop Drawings: Indicate manhole locations, elevations, piping sizes and elevations of penetrations.

#### 1.05 FIELD CONDITIONS

- A. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478 (ASTM C478M), with resilient connectors complying with ASTM C923 (ASTM C923M).
- B. Manhole Sections: ASTM D3753, glass-fiber reinforced polyester with integral steps.
- C. Concrete: As specified in Section 321313.
- D. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
- E. Concrete Reinforcement: As specified in Section 321313.
- F. Admixtures, General: Chemical type complying with ASTM C494/C494M (wet mix only).
- G. Air-Entraining Admixture: Complying with ASTM C260/C260M (wet mix only).

#### 2.02 COMPONENTS



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- A. Frame and Cover: ASTM A48/A48M Class 30B Cast iron construction, machined flat bearing surface, removable lockable lid, closed lid design; pedestrian and traffic rated; sealing gasket; lid molded with identifying name.
- B. Manhole Steps: Formed galvanized steel rungs; 3/4 inch diameter. Formed integral with manhole sections. Non-metallic manhole steps required for sewer manholes.
- C. Strap Anchors: Bent steel shape, galvanized to ASTM A123/A123M Grade specified for applicable material category.

## 2.03 CONFIGURATION

- A. Shaft Construction: Concentric with eccentric cone top section; lipped male/female dry joints; sleeved to receive pipe sections.
- B. Shape: Cylindrical.
- C. Clear Inside Dimensions: 48 inches diameter.
- D. Design Depth: As indicated on drawings.
- E. Clear Lid Opening: 26 inches diameter.
- F. Pipe Entry: Provide openings as required to achieve pipe routing on design drawings.
- G. Steps: 12 inches wide, 16 inches on center vertically, set into manhole wall.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into Work.
- C. Verify excavation for manholes is correct.

### 3.02 MANHOLES

- A. Place concrete base pad, trowel top surface level.
- B. Place manhole sections plumb and level, trim to correct elevations, anchor to base pad.



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- C. Form and place manhole cylinder plumb and level, to correct dimensions and elevations. As work progresses, build in fabricated metal items.
- D. Cut and fit for pipe.
- E. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.
- F. Set cover frames and covers level without tipping, to correct elevations.
- G. Coordinate with other sections of work to provide correct size, shape, and location.

### 3.03 SCHEDULES

- A. Storm Sewer Manholes: Precast concrete sections, galvanized steel steps, 48 inch inside dimension, to depth indicated, with bolted lid.
- B. Sanitary Sewer Manholes: Precast concrete sections, non-metallic steps, 48 inch inside dimension, to depth indicated, with bolted lid.

### 3.04 MANHOLE FRAME AND COVERS

- A. Manholes for storm drain shall state "Storm Drain"
- B. Manhole covers for sewer system shall state "Sewer" and not "Padre Dam Municipal Water District Sewer" as the sanitary sewerage system for this project is private.

END OF SECTION



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SECTION 33 10 00 - WATER DISTRIBUTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes water-distribution piping and specialties outside the building for the following:
  - 1. Water services.
  - 2. Fire service main.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Water Agencies' Standards (WAS): Standard Specifications, most current edition, as referenced by WAS Standard Drawings referenced on plans.

1.03 DEFINITIONS

- A. Fire Service Main: Exterior site water piping serving fire hydrants and for and fire-suppression piping.
- B. Water-Distribution Piping: Interior domestic-water piping.
- C. Water Service: Exterior domestic-water piping branch from service main to building.

1.04 SUBMITTALS

- A. Product Data: For the following:
  - 1. Piping specialties.
  - 2. Water meters.
  - 3. Valves and accessories.
  - 4. Fire department connections
  - 5. Backflow preventers
- B. Coordination Drawings: For piping and specialties including relation to other services in same area. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.
- C. Field Quality-Control Test Reports: From Contractor.



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- D. Operation and Maintenance Data: For specialties to include in emergency, operation, and maintenance manuals. In addition to items specified in the "Closeout Submittals" section in Division 01, include the following:
  - 1. Valves.

1.05 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Comply with standards of NFPA and OCFD for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
- D. Comply with FM's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- E. NFPA Compliance: Comply with NFPA 24 2010 Edition for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- F. NSF Compliance:
  - 1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
  - 2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves according to the following:
  - 1. Ensure that valves are dry and internally protected against rust and corrosion.
  - 2. Protect valves against damage to threaded ends and flange faces.
  - 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves according to the following:
  - 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
  - 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.



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- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.07 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Owner Project Manager not less than two weeks in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without written permission.
  - 3. If utility interruption is for more than eight hours, provide temporary utility service.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The following products shall be used as shown on the Drawings.

2.02 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
  - 1. Copper Fittings: ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings.
- B. Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.
  - 1. Copper Fittings: ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings.
- C. Bronze Flanges: ASME B16.24, Class 150, (DR14) with solder-joint end. Furnish Class 300 flanges if required to match piping.
- D. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.



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2.03 PVC PIPE AND FITTINGS

- A. PVC, AWWA Pipe: AWWA C900, Class 200, (DR14) with bell end with gasket and spigot end.
  - 1. Comply with UL 1285 for fire-service mains.
  - 2. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Gaskets: AWWA C111, rubber.
    - b. Coating: Fusion bonded epoxy coating, both interior and exterior per AWWA C116.
  - 3. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and stainless-steel bolts.
    - b. Coating: Fusion bonded epoxy coating, both interior and exterior per AWWA C116.

2.04 JOINING MATERIALS

- A. Transition Couplings:
  - 1. Underground Piping, NPS 1-1/2 and Smaller: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
  - 2. Underground Piping, NPS 2 and Larger: AWWA C219, metal, sleeve-type coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
  - 3. Aboveground Piping: Pipe fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Brazing Filler Metals: AWS A5.8, BCuP Series.
- C. Soldering Flux: ASTM B 813, water-flushable type.
- D. Solder Filler Metal: ASTM B 32, lead-free type with 0.20 percent maximum lead content.
- E. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.05 CORROSION-PROTECTION ENCASUREMENT FOR PIPING

- A. Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105, Polyethylene (PE) film, 0.008-inch minimum thickness, tube or sheet.



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2.06 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:
  - 1. Manufacturers:
    - a. American AVK Co.; Valves & Fittings Div.
    - b. American Cast Iron Pipe Co.; American Flow Control Div.
    - c. Crane Co.; Crane Valve Group; Stockham Div.
    - d. Or equal.
  - 2. Nonrising-Stem, Resilient-Seated Gate Valves: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
    - a. Minimum Working Pressure: 200 psig.
    - b. End Connections: Mechanical joint or flanged.
    - c. Interior Coating: Complying with AWWA C550.
- B. UL/FM, Cast-Iron Gate Valves:
  - 1. Manufacturers:
    - a. American Cast Iron Pipe Co.; American Flow Control Div.
    - b. Central Sprinkler Company.
    - c. Crane Co.; Crane Valve Group; Stockham Div.
    - d. Or equal.
  - 2. OS&Y, Rising-Stem Gate Valves: UL 262, FM-approved iron body and bonnet, bronze seating material, and outside screw and yoke.
    - a. Minimum Working Pressure: 175 psig.
    - b. End Connections: Flanged.
- C. Bronze Gate Valves:
  - 1. Manufacturers:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Div.
    - d. Or equal
  - 2. OS&Y, Rising-Stem Gate Valves: UL 262, FM-approved bronze body and bonnet, outside screw and yoke, and bronze stem.
    - a. Minimum Working Pressure: 175 psig.
    - b. End Connections: Threaded.
  - 3. Ball valves: Ball valves shall be Apollo to match campus standards.

2.07 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Tapping-Sleeve Assemblies: Comply with MSS SP-60. Include sleeve and valve compatible with drilling machine.
  - 1. Manufacturers:
    - a. Grinnell Corporation; Mueller Co.; Water Products Div.
    - b. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
    - c. McWane, Inc.; Kennedy Valve Div.



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- d. Or equal
  - 2. Tapping Sleeve: Cast- or ductile-iron or stainless steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
  - 3. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.
- B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, triangular cap with lettering "WATER", bottom section with base of size to fit over valve, and approximately 5-inch- diameter barrel.
- 1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- C. Indicator Posts: UL 789, FM-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.08 CHECK VALVES

- A. AWWA Check Valves: As specified on the Drawings
- 1. Manufacturers:
    - a. American AVK Co.; Valves & Fittings Div.
    - b. American Cast Iron Pipe Co.; American Flow Control Div.
    - c. Crane Co.; Crane Valve Group; Crane Valves.
    - d. Or equal.

2.09 FIRE DEPARTMENT CONNECTIONS

- A. Manufacturers:
- 1. Elkhart Brass Mfg. Co., Inc.
  - 2. Grinnell Corporation.
  - 3. Guardian Fire Equipment, Inc.
  - 4. Or equal.
- B. Exposed, Freestanding, Fire Department Connections: UL 405, cast-bronze body, with thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- high brass sleeve; and round escutcheon plate.
- 1. Connections: Two NPS 2-1/2 inlets and one NPS 4 outlet.
  - 2. Inlet Alignment: Inline, horizontal.
  - 3. Finish Including Sleeve: Polished chrome plated or polished bronze as selected by the Owner Project Manager.

Escutcheon Plate Marking: "AUTO SPKR."



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2.10 FIRE HYDRANTS

- A. Per WAS Standard Specifications

2.11 BACKFLOW PREVENTERS

- A. Per WAS Standard Specifications

PART 3 - EXECUTION

3.01 EARTHWORK

- A. Refer to Section 31 23 00.

3.02 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
  - 1. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with keyed couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
  - 2. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure. Refer to Division 2 Section "Utility Materials" for joining piping of dissimilar metals.
- B. Provide stainless steel bolts, nuts and washers for piping both above ground and below ground.

3.03 PIPING INSTALLATION

- A. Refer to Section 33 05 00.
- B. Provide concrete thrust blocks or restrained joints at pipe tees and bends as specified on the Drawings.
- C. Unless otherwise specified by local code having jurisdiction, potable water shall maintain 10 foot horizontal and 1 foot vertical clearance from sanitary sewer pipe lines.



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3.04 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. UL/FM Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- C. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
- D. Water-Regulating Valves: Install aboveground between shutoff valves. Install reduced-size lockable valved bypass appropriate for demand. Provide valve suitable for throttling service such as globe or v-port ball valve. Under no circumstances will full-size gate valves be permitted for this service.
- E. Relief Valves: Install aboveground with shutoff valve on inlet.
- F. Detector Check Valves: Install aboveground.

3.05 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install fire department connections.
- B. Install ball drip valves at each check valve for fire department connection to mains.
- C. In areas near vehicle access, install protective pipe bollards on sides of each freestanding fire department connection to protect from accidental damage.

3.06 IDENTIFICATION

- A. Install continuous underground warning tape during backfilling of trench for underground water-service piping. Locate below finished grade, directly over piping. See Section 33 05 00 – Installation of Buried Pipe for underground warning tapes.
- B. Install solid copper tracer wire with all underground non-metallic piping.

3.07 CLEANING

- A. Refer to Section 33 13 00.

END OF SECTION



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SECTION 33 13 00 - DISINFECTION OF WATER UTILITY PIPING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section describes the disinfection of potable water mains, services, appurtenances, and connections by chlorination, in accordance with AWWA C601 and as specified herein. Contractor to provide written copies of all test results from this section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. 33 14 00 – Hydrostatic Testing of Pressure Pipelines.

1.03 JOB CONDITIONS

- A. Potable water shall be used for chlorination. See Special Provisions section for availability of water.
- B. Requests for use of water from the Owner's waterlines shall be submitted 48 hours in advance.

PART 2 - MATERIALS

2.01 LIQUID CHLORINE SOLUTION

- A. Liquid chlorine solution shall be in accordance with the requirements of ANSI/AWWA B301, and shall be injected with a solution feed chlorinator and a water booster pump.

2.02 CALCIUM HYPOCHLORITE (DRY)

- A. Calcium Hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300, and shall be dissolved in water to a known concentration in a container and pumped into the pipeline at a measured rate.

2.03 SODIUM HYPOCHLORITE (SOLUTION)

- A. Sodium Hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300, and shall be diluted in water to desired concentration and pumped into the pipeline at a measured rate.

2.04 SODIUM HYPOCHLORITE TABLETS AND ADHESIVE

- A. Chlorine Content: The tablets shall have an average weight of 0.009 pounds each and shall contain not less than 70% of available chlorine.



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- B. Adhesive: Adhesive shall be a type that will not impart taste, odor, or detrimental compounds to the water supply.
- C. Storage: Proper care shall be taken to store hypo-chlorite tablets in tightly closed containers where they will not be accessible to children or unauthorized persons.

2.05 CHLORINE RESIDUAL TEST KIT

- A. For measuring chlorine concentration, a medium range, drop count, titration kit or an orthotolidine indicator comparator with wide range color discs shall be used. The kit shall be capable of determining chlorine concentration in the range 1.0 to 25 mg/L. An adequate number of kits shall be maintained by the Contractor in good working order and available for immediate test of residuals at points of sampling.

PART 3 - EXECUTION

3.01 PROCEDURE

- A. Contractor shall notify the Owner Project Manager two (2) working days prior to chlorination of facilities.
- B. All require corporation stops and other plumbing materials necessary for chlorination or flushing of the main shall be installed by and at the expense of the contractor.
- C. All mains shall be thoroughly flushed prior to disinfection.
- D. Every connection served by a main being disinfected shall be tightly shutoff before water is applied to the main. Care shall be taken to expel all air from the main and services during the filling operation.
- E. Water shall be fed slowly into the pipeline with chlorine applied in amounts to produce a dosage of not less than 50 ppm nor more than 100 ppm in all sections of the pipeline and appurtenances.
- F. Treated water shall be retained in the system for a minimum of 24 hours and shall contain a chlorine residual of not less than 25 ppm at the end of the retention period in all sections being disinfected.

3.02 CONCURRENT TESTING

- A. Disinfecting mains and appurtenances, and hydrostatic testing may run concurrently for the required 24-hour test period. In the event there is leakage and repairs are necessary, disinfection of the pipeline shall be repeated as provided in this section.

3.03 REPETITION OF PROCEDURE

- A. If the initial chlorination fails to produce required residuals and bacteriologic tests, chlorination and testing shall be repeated until satisfactory results are obtained.



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3.04 FLUSHING

- A. After confirming the chlorine residual, excess chlorine solution shall be flushed from the pipeline until the chlorine concentration in the water leaving the pipe is within 0.5 mg/L of the replacement water.

3.05 BIOLOGICAL TESTING

- A. Samples from the newly disinfected facilities will be collected by the contractor and tested by a state certified laboratory. All facilities must successfully pass bacteriological tests prior to connecting to the existing system.

END OF SECTION



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SECTION 33 14 00 - HYDROSTATIC TESTING OF PRESSURE PIPELINES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. These specifications designate the requirements for field pressure and leakage testing of all new and replaced existing water mains intended for the conveyance of potable, fire water and reclaimed water under pressure. The Contractor shall furnish all labor, materials (including water), tools, and equipment necessary to provide and complete field testing as specified. All pipelines shall be tested for water tightness by subjecting each section to Hydrostatic Pressure and Leakage Tests in accordance with the applicable requirements of AWWA C 600 except as modified herein.

1.02 SUBMITTALS

- A. Hydrostatic test results shall be submitted for review and approval.

1.03 JOB CONDITIONS

- A. For potable water pipelines, obtain and use only potable water for hydrostatic testing.
- B. Submit request for use of water from waterlines to Owner Project Manager 48 hours in advance.
- C. The testing shall be witnessed by the Owner Project Manager.

1.04 PAYMENT

- A. The unit price paid for installation of pipe will include full compensation for furnishing the labor, materials, tools, and equipment, and doing all work involved in hydrostatic testing of pressure pipelines as specified herein.

PART 2 - MATERIALS

2.01 MANUAL AIR-RELEASE VALVES

- A. Provide temporary manual air-release valves for pipeline test. Construct the pipe outlet in the same manner as for a permanent air valve and after use, seal with a blind flange, pipe cap, or plug and coat equal to the adjacent pipe.

PART 3 - EXECUTION

3.01 TESTING AND DISINFECTION SEQUENCE

- A. Perform required chlorination subsequent to hydrostatic testing, except when pipeline being tested is connected to a potable waterline.



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- B. The test shall be made prior to connecting the new line with existing pipe and mains. The test shall further be conducted with valves open, and the open ends of pipes, valves, and fittings suitably closed. Valves shall be operated and checked during to the test period. No leakage shall be allowed when testing across any valves.

3.02 INITIAL PIPELINE FILLING

- A. Maximum rate of filling shall not cause water velocity in pipeline to exceed 1 fps. Filling may be facilitated by releasing air manually.

3.03 PRESSURE AND DURATION OF TEST

- A. All pipe shall be tested at a hydrostatic pressure of 120 percent of maximum rated operating pressure of the pipe, but shall be not less than 200 psi.
- B. When the system is pumped to the required test pressure, the pump shall be disconnected and maintain the test pressure for the following duration by restoring it whenever it falls an amount of 10 psi: pipe of 18 inches in diameter and smaller, 4 hours; over 18 inches to 36 inches in diameter, 8 hours; and over 36 inches in diameter, 24 hours.
- C. Temporary or permanent thrust blocks shall be cast-in-place as required prior to tests, and the Contractor shall provide all necessary braces, plugs, thrust blocks, caps, flanges, and other materials to permit proper conduct of the pressure testing. Concrete blocks shall be cast not less than 5 days before the test.
1. All concrete anchor blocks shall be allowed to cure a sufficient time to develop a minimum strength of 2,000 psi before testing, unless otherwise directed by the Owner Project Manager.

3.04 ALLOWABLE LEAKAGE

- A. Permit one to three days for the filled pipeline to soak and to release entrapped air. Apply the test pressure with a positive displacement pump. Provide a snubber or dampener between the pump and the pipeline to reduce instantaneous pressure pulses to 10% of the specified test pressure. Draw from containers in which the volume of water can be readily measured or through a positive displacement meter. The amount of water used to maintain the test pressure during the test period is the leakage. Determine the allowable leakage by the following:

$$L = \frac{N \cdot D \cdot (P)^{1/2}}{7,400}$$

where L is the allowable leakage in gallons per hour,

N is the number of pipe joints in the test section,

D is the inside pipe test diameter in inches,

P is the pipe test pressure (psi), which is defined as the average of the highest and lowest test pressures in the pipe section being tested.

\*N does not include any flanged or welded joints.



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3.05 REPETITION OF TEST

- A. If the actual leakage exceeds the allowable, locate and correct the faulty work and repeat the test. Restore the work and all damage resulting from the leak and its repair at no additional cost to the Owner. All visible leakage shall be eliminated.

END OF SECTION



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SECTION 333000 - SANITARY SEWER PIPING AND APPURTENANCES

PART 1 - GENERAL

1.01 SUMMARY

- A. The locations of sewer rehabilitation work are listed and graphically shown in the Drawings. Replacement and construction locations provided in this document are approximate and based on record data that may or may not be accurate. The Contractor shall verify location of the sewer pipes prior to construction. Verification may be conducted by potholing, or surface measurement.

1.02 REFERENCES

- A. Standard Specifications for Public Works Construction (SSPWC) "Greenbook" most current edition, including all supplements thereto issued prior to bid opening date, Exclusive of Part 1.
- B. Standard Plans for Public Works Construction (most current edition)
- C. Caltrans Standard Specifications, most current edition.

1.03 SUBMITTALS

- A. General. The Contractor shall submit samples, drawings, and data for the Engineer's approval, which demonstrate fully that the construction, and the materials and equipment to be furnished will comply with the provisions and intent of these Plans and Specifications. Submittals shall be accompanied by a letter of transmittal and shall be in strict accordance with the provisions of this section. Submit priority of processing when appropriate.

- 1. Specific items to be covered by the submittals shall include, as a minimum, the following:

- a. Samples.

- b. Substitutions. The Contract is based on the materials, equipment, and methods described in the Contract Documents. All substitutions are subject to the Engineer's approval. The Engineer will consider proposals for substitution of materials, equipment, and methods only when full and complete technical data and all other information accompany such proposals as required by the Engineer to evaluate the proposed substitution.

- c. As-built drawings. The Contractor shall prepare the AS BUILT drawings. The Contractor shall deliver to the Owner one complete set of final AS BUILT hard copy drawings together with a set of AutoCAD drawing files on 3.5 inch diskettes showing completed construction, for the Owner records before the Contract will be accepted by the Owner.

- B. Shop Drawings. All shop drawings shall be produced to a scale sufficiently large to show all pertinent features of the item and its method of connection to the work.



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- C. Submittals. Completely identify each submittal and resubmittal by showing at least the following information:
1. Name and address of submitter, plus name and telephone number of the individual who may be contacted for further information.
  2. Name of project as it appears in these Specifications and Specifications number.
  3. Drawing and Specifications section number other than this section to which the submittal applies.
  4. Whether this is an original submittal or resubmittal.
- D. For samples, indicate the source of the sample.

1.04 PRODUCT HANDLING

- A. Delivery: Handle pipe carefully to ensure delivery at the project site in sound, undamaged condition. Damaged pipe will be rejected on site. Contractor shall replace damaged pipe at no additional expense to the Owner.
- B. Storage: Do not store materials directly on the ground. Adequately support piping to prevent warpage. Use protective covers where pipe may be damaged by direct sunlight.

1.05 INSPECTION

- A. All materials furnished and work done under this Contract will be subject to rigid inspection. The Contractor shall furnish, without extra charge, the necessary test pieces and samples, including facilities and labor for obtaining them, as requested by the Engineer. The Engineer, or his/her authorized agent or agents, at all times shall have access to all parts of the shop and the works where such materials under his/her inspection is being manufactured or the work performed. Work or material that does not conform to these Specifications, although accepted through oversight, may be rejected at any stage of the work. Whenever the Contractor is permitted or directed to do night work or to vary the period during which work is carried on each day, he/she shall give the Engineer due notice, so that inspection may be provided. Such work shall be done under regulations to be furnished in writing by the Engineer.
- B. There will be no charges for the inspection of overtime work ordered by the Engineer or required by these Specifications unless inspection is required for defective work requiring repairs by the contractor.

PART 2 - PRODUCTS



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2.01 PIPE

- A. PVC gravity – Pipe shall meet the requirements of ASTM D3034 and have a rating of either SDR 26 or SDR 35 (size of pipe and rating to be provided shall be as shown on Drawings). Pipe shall be in accordance to subsection 207-16 of the Standard Specifications for Public Works Construction. Pipe shall be for sewer mains and shall be colored green.

2.02 JOINTS AND FITTINGS

- A. All fittings including 1/8 bends shall be gasket push-on type.
- B. Elastomeric Gasket Joint: Manufacturer's standard. Integrally formed bell, push-fit, rubber gasketed joint system.
- C. Lubricant: Manufacturer's standard.
- D. Fittings: Size, grade, joint type, and lining to match pipe, and as recommended by the pipe manufacturer.
  - 1. PVC fittings shall meet the requirements of ASTM D3034, SDR 35, and shall have gasketed joints. Manufacturers: GPK Products; Vassiallo; or equal.
  - 2. DIP fittings shall conform to AWWA standard C-110, standard outside coating and cement mortar lining. Joints shall conform to AWWA standard C-111, mechanical or push-on joints.
- E. Pipe Joints.
  - 1. PVC pipe shall have elastomeric gasket joints in accordance with Subsection 207-17.3.2 of the Standard Specifications. Joints in accordance with ASTM D312.
  - 2. DIP joints shall conform to AWWA standard C-111, mechanical or push-on joints.

2.03 COUPLINGS FOR DISSIMILAR PIPES

- A. Transition type couplings shall be factory manufactured to ensure tight fit and smooth flow transition at the joint. Poured concrete collar and similar coupling methods will not be accepted.

2.04 STRUCTURES FOR SEWERS

- A. Manholes shall be constructed at locations shown on the plans in accordance with the plans and specifications.
- B. The Contractors attention is directed to Sections 70 1.02E, "Miscellaneous Iron and Steel," 70 1.02F, "Reinforcement," 70 1.02G, "Concrete," 70 1.02H, "Precast Concrete Structures," and 70 1.02L, "Excavation and Backfill" of the Caltrans Standard Specification for which the construction and installation of manholes and inlets will apply.



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- C. Brick: Brick for manholes shall conform to ASTM C 32 Grade SS or SM.
- D. Concrete: All concrete shall be Class N-5.5 (f'c equal 3000 psi) (f'c equal 20.7 megapascals), air entrained and shall conform to ASTM C94 for ready mixed concrete.
- E. Mortar and Plaster: Mortar and plaster for masonry manholes shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in the amount of not more than 25% of the volume of cement.
- F. Backfill: Granular fill used as backfill shall conform to fill requirements specified in Section 31 23 33, TRENCHING, BACKFILLING, AND COMPACTION.
- G. Reinforcing Steel: Reinforcing steel shall be deformed bars except where otherwise noted on Drawings and conform to ASTM A 615, Grade 40.
- H. Manhole steps shall be not less than 14 inches in width, built into and anchored in the walls and spaced uniformly 12 inches apart. The top step shall be 12 inches max below the top surface and the bottom step shall be 16 inches max above the floor. Steps will not be required unless the depth from cover of manhole or inlet to invert of main sewer exceeds 4 feet.

### PART 3 - EXECUTION

#### 3.01 GENERAL

- A. The contractor shall provide all labor, materials, tools, equipment, and services required for the complete and proper completion of all the work as shown on the drawings and/or outlined in these specifications.
- B. Work shall include items not specifically mentioned herein or noted on plans but necessary to make a complete working installation of all systems shown or described herein.
- C. During construction of sanitary sewer facilities, existing sewage flow shall be maintained and conveyed in a watertight manner downstream of the work area.
- D. All excavation spoils and existing pipelines to be replaced shall be removed from the job site and disposed of at a legal disposal site.
- E. Construct the gravity sewer system, complete with appurtenances, to the lines and grades shown.

#### 3.02 TRENCHING

- A. Refer to Section 31 23 33.



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3.03 BEDDING

- A. Refer to Section 31 23 00 and Section 31 23 33.

3.04 INSTALLATION

- A. Inspection: Inspect pipe for defects before lowering into the trench. Defective, damaged, or unsound pipe will be rejected.
- B. The existing sanitary sewer line shall be kept operational until the new line is finished and connected.
- C. Laying: After the trench bottom has been properly prepared for pipe installation as specified in Section 330500, lay pipe upgrade with the spigot ends pointing in the direction of flow. Lay each length true to line and grade, to form smooth joint transitions and to prevent sudden offsets of the flow line.
- D. Cleaning: As work progresses, clear the sewer pipe interior of dirt and other debris by keeping swabs in the pipe and pulling them forward past each completed joint.
- E. Pipe Cutting: Cutting for closure or other reasons shall be done neatly by methods recommended by the manufacturer. Sharp edges shall be smoothed to prevent gasket damage.
- F. Jointing: Clean gaskets and seats of foreign materials prior to joint assembly. Apply lubricant as recommended by the pipe manufacturer.
  - 1. Push On Joint: Carefully insert the spigot end into the bell to prevent entry of dirt and incorrect entry angle. With suitable fork tool, crowbar, or by hand, make the joint to the insertion depth recommended by the manufacturer. When the selected pipe uses joints not designed for full depth insertion, prevent further closure of previously completed joints by restraining movement of the installed line while making succeeding joints.
  - 2. Mechanical Joint: Carefully center the spigot in the bell and position the gasket evenly in the seat. Tighten bolts alternately to an even torque, causing the follower gland to expand the gasket uniformly for a tight seal.
  - 3. Plain End Jointing: Install factory made couplers in accordance with manufacturers' directions. Center the coupling collar over the joint and tighten bolts or bands evenly.
- G. Manholes:



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1. General. Construct manholes of concrete with cast iron frames and covers, and in accordance with the Drawings, Standard Drawings, and provisions of the specifications. Precast reinforced concrete manholes conforming to ASTM C 478 will be acceptable subject to submission and approval of the Shop Drawings. The invert channels shall be smooth and semi-circular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large radius as the size of the manhole will permit. Make changes in size and grade of the channels gradually and evenly. The invert channels may be formed directly in the concrete of the manhole base, or may be built up with brick and mortar or may be half tile laid in concrete, or may be constructed by laying full-section sewer pipe through the manhole and breaking out the top half after the surrounding concrete has hardened. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels not less than 1 inch per foot nor more than 2 inches per foot. Any material excavated beneath pipe entering and leaving manholes and inlets shall be replaced with concrete. Such concrete fill shall extend to the center of pipe for a distance of at least 3 feet from face of manhole and inlet and shall terminate at a joint.
2. Jointing and Plastering. Fill mortar joints completely and make them smooth and free from surplus mortar on the inside of the manhole. Plaster brick manholes with half inch of mortar over the entire outside surface of walls. Lay brick radially with every sixth course laid as a stretcher course. When precast concrete manhole sections are used, set each section in a fresh bed of mortar to make a mortar joint with a minimum thickness of 1/8 inch. Point up all joints inside and out.
3. Frames and Covers. Set the cast iron manhole frame in a bed of mortar and adjust to the elevations shown on the Drawings.
4. Inspection manholes, branch connections and elbows on large diameter pipe shall be built to conform to details indicated on the Drawings.

3.05 PRESERVATION, REMOVAL, AND ABANDONMENT

- A. Where a pipe or other facility is shown on the plans but is not to be replaced, the Contractor shall take precautions as necessary to not disturb the existing facilities during the course of construction. The Contractor may elect to remove existing facilities and replace it with new facility at locations where it is not feasible to preserve existing facility.
- B. Where it is shown on the plans that existing sewer pipe or manhole is to be removed, the Contractor shall remove the facility in its entirety and back fill per the typical trench section detail and compacted to achieve minimum densities as shown on the typical trench section.
- C. At locations on the plans where existing pipes are to be abandoned, the Contractor shall neatly cut the pipe to be abandoned, fill with grout, and construct a water tight brick and mortar plug with smooth grout all around.

3.06 BACKFILLING OF SELECT MATERIAL

- A. Refer to Sections 31 23 00 and 31 23 33.



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3.07 FINAL PIPE CLEANING

- A. Prior to testing, clean all lines to be tested by high pressure water jet or mechanical means. Remove and dispose of fluidized material as approved.

3.08 TESTING

- A. General: All gravity sewer pipes and service laterals shall be tested for exfiltration and/or infiltration and deflection, as specified. All maintenance holes shall be tested for leakage, as specified. Maintenance holes shall be tested prior to backfill placement, whereas all pipe shall be backfilled prior to testing. All leakage tests of sanitary sewer systems shall be in conformance with SSPWC Section 306-1.4.1. For pressure sewers (force main) tests, the water pressure shall be measured at the lowest point of the pipeline section being tested.
- B. Water Exfiltration Test shall be in conformance with SSPWC Section 306-1.4.2.
- C. Water Infiltration Test shall be in conformance with SSPWC Section 306-1.4.3. Unless otherwise specified, infiltration will be measured by the contractor using measuring devices approved by the engineer.
- D. Air Pressure Test shall be in conformance with SSPWC Section 306-1.4.4.
- E. Water Pressure Test shall be in conformance with SSPWC Section 306-1.4.5.
- F. Deflection Test: All flexible and semi-rigid main line pipe shall be tested in accordance with SSPWC Sections 306-1.2.12 and 306-1.2.13 for deflection, joint displacement, or any other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent resurfacing.
- G. All sewer maintenance holes shall be hydrostatically tested for leakage after installation, but prior to being backfilled. Prior to hydrostatic testing, all maintenance holes shall be visually inspected for leaks. All leaks or cracks shall be repaired by the contractor, prior to hydrostatic testing, to the satisfaction of the engineer and the inspector. All pipes entering the maintenance hole shall be sealed at a point outside the maintenance hole walls so as to include testing of the pipe/maintenance hole joints. The maintenance hole shall be filled with water to a level 2 inches below the top of the frame. Safety lines shall be secured to all plugs utilized. After a period of at least one hour to allow the water level to stabilize, the maintenance hole shall be refilled and the water level shall be checked. The water level shall again be checked after a period of 4 hours. If the water level is reduced by more than 1/4-inch, the leakage shall be considered excessive, and the contractor shall be required to make all necessary repairs and retest the maintenance hole. The exterior of the maintenance hole shall be inspected during this period for visible evidence of leakage. Visible moisture, sweating, or beads of water on the exterior of the maintenance hole shall not be considered leakage, but any water running across the surface will be considered leakage and shall be repaired to the satisfaction of the Owner's Project Manager and the engineer regardless of the volume of water lost.



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- H. CCTV Inspection: All sewer mains shall be inspected with CCTV inspection to verify proper pipe joint connections and that no high points or low points exist along the length of sanitary sewer piping.

END OF SECTION



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SECTION 334000 - STORM DRAIN PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide all storm drains as shown on the Drawings and as specified herein, complete.
  - 1. Drainage grates shall have maximum ½" openings perpendicular to the path of travel per CBC 11B-302.3.
- B. Work Specified in Other Sections:
  - 1. Section 31 23 33: Trenching, Backfilling, and Compaction.
  - 2. Section 32 12 16: Asphalt Concrete Pavement.
  - 3. Section 32 13 13: Sitework Concrete.
  - 4. Section 33 05 00: Installation of Buried Pipe

1.2 RELATED DOCUMENTS

- A. Drawings, Specifications and provisions of Construction Contract, including General, Special and Supplementary Conditions and other General Requirements.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of the specified materials, quantity and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Material Testing: Refer to Division 01.
- C. Allowable Tolerances: The allowable dimensional alignment for gravity sewers shall be as follows:
  - 1. Vertical: + 0.02 feet
  - 2. Horizontal: + 0.50 feet

1.4 SUBMITTALS

- A. Refer to Section Div. 01 for procedures.
- B. Test Reports: Contractor's testing agency will report all results of the tests to Owner's Representative who will approve or disapprove Contractor's work.
- C. The following tests shall be performed by Contractor's testing agency:
  - 1. Closed circuit TV inspection video tape and report, if used.
- D. Shop Drawings and Product Data: The following list includes the required shop drawings and samples that shall be submitted.
  - 1. Storm drain pipe and fittings.



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2. Cast iron or ductile iron castings.
  3. Manholes and structures.
  4. Television inspection, video tapes, if used.
- E. Certificates: Furnish manufacturer's certified analysis or certificate of compliance for all shipments of pipe, cast iron frames, grates and covers, valves and other miscellaneous material.
- F. Record Documents: At closeout, submit Record Drawings of installed utility piping and products, in accordance with Division 01.

1.5 JOB CONDITIONS

- A. All drains shall be connected to the building service at a point 5 feet outside the building unless otherwise indicated.
- B. Protection of Existing Utilities Structures: Protect the existing utilities shown on the Drawings, or the locations of which are known prior to excavation, from damage during excavation and backfilling of trenches and, if damaged, repair them at Contractor's expense.
- C. Removal of Utilities: All utilities indicated to be removed or abandoned shall be removed or abandoned in accordance with the requirements of the codes, as listed in Division 01.
- D. The Drawings are diagrammatic, but shall be followed as closely as actual construction permits. All deviations from the Drawings required to make work conform to the site conditions, and to Work of others, shall be made only as necessary as approved by the Contractor and Engineer. The Sub-Contractor shall verify all dimensions prior to starting work.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Brick: Brick for manholes shall conform to ASTM C 32 Grade SS or SM.
- B. Concrete: All concrete shall be Class N-5.5 (f'c equal 3000 psi) (f'c equal 20.7 megapascals), air entrained and shall conform to ASTM C94 for ready mixed concrete.
- C. Mortar and Plaster: Mortar and plaster for masonry manholes shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in the amount of not more than 25% of the volume of cement.
- D. Inlet Covers and Grates: Area drain and atrium drain grates per Brooks Products, Kristar, or NDS Products or equal. Size as shown on Drawings.
- E. Backfill: Granular fill used as backfill shall conform to fill requirements specified in Section 31 23 33, TRENCHING, BACKFILLING, AND COMPACTION.



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- F. Reinforcing Steel: Reinforcing steel shall be deformed bars except where otherwise noted on Drawings and conform to ASTM A 615, Grade 40.
- G. Manhole steps shall be not less than 14 inches in width, built into and anchored in the walls and spaced uniformly 12 inches apart. The top step shall be 12 inches max below the top surface and the bottom step shall be 16 inches max above the floor. Steps will not be required unless the depth from cover of manhole or inlet to invert of main sewer exceeds 4 feet.
- H. Storm Drain:
  - 1. Pipe. Use one of the following as shown on the Drawings:
    - a. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.
    - b. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794 pipe, with bell-and-spigot ends; ASTM D 3034 fittings, with bell ends; and ASTM F 477, elastomeric seals.

## 2.2 PRODUCTS

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. All products specified herein and shown on the Drawings shall be installed per manufacturer's instructions.

### 3.2 SYSTEM LAYOUT

- A. Layout the system determining proper elevations for all components from the lines and grades shown on the Drawings.

### 3.3 EXCAVATING, BACKFILLING, AND COMPACTING

- A. Perform excavating, backfilling, and compacting for the pipe and structures in accordance with the provisions of Section 312333 of the Specifications.

### 3.4 INSTALLATION

- A. Pipe:
  - 1. Laying Pipe. Shape the bottom of the trench by hand to give uniform circumferential support to the lower fourth of each pipe. Where applicable, pipe laying shall proceed upgrade with the tongue or spigot ends pointing in the direction of the flow. Each pipe shall be laid true to line and grade indicated on the Drawings and in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the low line. As the work progresses, clean the interior of the pipe of all dirt and superfluous materials. Where cleaning after laying is difficult because of small pipe size, keep a swab or drag in the pipe and pull forward past each joint



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immediately after the joining has been completed. If the maximum width of the trench at the top of the pipe as specified is exceeded, install such concrete cradling, pipe encasement or other bedding as approved by Owner's Representative to support the added load of the backfill. Keep trenches for all sections of the pipe free from water until the pipe-jointing material has set and the trench has been backfilled. Do not lay pipe when the condition of the trench or the weather is unsuitable for such work. At times when the work is not in progress, keep open ends of pipes and fittings securely closed so that no trench water, earth or tamped backfill, can enter. Encase the pipe in concrete or support it on a concrete cradle as approved.

2. Pipe Joints.
  - a. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric seal joints or ASTM D 3034 for elastomeric gasket joints.
  - b. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
3. Connection to Existing Pipe. Make connections to existing pipe by the use of one of the joints described above where possible to do so. Where the end of the existing pipe is broken or a standard joint is otherwise impracticable, install a concrete collar to make the connection.
4. Connection to Existing Manholes. Make pipe connections to existing manholes in such a manner that the finished work will conform to the essential applicable requirements for new manholes, including all necessary concrete work, cutting and shaping.
5. Wye Branches. Install commercially manufactured wye branches where indicated on the Drawings. Cutting into the pipe for connections will not be permitted except as approved by Owner's Representative.
  - a. Pipe Plugs. Plug all open ends of wye branches with a manufactured stopper installed in accordance with provisions for jointing. Plug open ends of sewer pipe with a manufactured stopper or concrete masonry. Concrete masonry plugs shall have a minimum thickness of 4 inches. Install all plugs so that the open end of the pipe is permanently sealed but can be removed for future extensions without damaging the pipe.
6. Jacking Pipe. Jack pipe into place at the locations shown with the minimum lengths of jacked pipe as shown on the Drawings. At Contractor's option, install additional pipe beyond these limits by jacking methods, at no additional cost to Owner. Prevent damage to the pipe being jacked. A corrugated metal casing pipe may be jacked in place ahead of the carrier pipe where direct jacking is not possible or where called for on the Drawings. Fill the space between the carrier pipe and the casing pipe completely with sand after the carrier pipe has been aligned.
  - a. Remove materials excavated during the jacking operation so as to prevent cave-in or flow of material into the pipe. Provide shoring to prevent any damage to any facilities above or below ground. Promptly repair any damage that may occur at Contractor's expense.
  - b. Jacking operations shall be continuous from the time that the jacking operation is started until it is completed.

B. Manholes:

1. General. Construct manholes of brick or concrete with cast iron frames and covers, and in accordance with the Drawings, Standard Drawings, and provisions of the



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specifications. Precast reinforced concrete manholes conforming to ASTM C 478 will be acceptable subject to submission and approval of the Shop Drawings. The invert channels shall be smooth and semi-circular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large radius as the size of the manhole will permit. Make changes in size and grade of the channels gradually and evenly. The invert channels may be formed directly in the concrete of the manhole base, or may be built up with brick and mortar or may be half tile laid in concrete, or may be constructed by laying full-section sewer pipe through the manhole and breaking out the top half after the surrounding concrete has hardened. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels not less than 1 inch per foot nor more than 2 inches per foot. Any material excavated beneath pipe entering and leaving manholes and inlets shall be replaced with concrete. Such concrete fill shall extend to the center of pipe for a distance of at least 3 feet from face of manhole and inlet and shall terminate at a joint.

2. Jointing and Plastering. Fill mortar joints completely and make them smooth and free from surplus mortar on the inside of the manhole. Plaster brick manholes with half inch of mortar over the entire outside surface of walls. Lay brick radially with every sixth course laid as a stretcher course. When precast concrete manhole sections are used, set each section in a fresh bed of mortar to make a mortar joint with a minimum thickness of 1/8 inch. Point up all joints inside and out.
3. Frames and Covers. Set the cast iron manhole frame in a bed of mortar and adjust to the elevations shown on the Drawings.
4. Inspection manholes, branch connections and elbows on large diameter pipe shall be built to conform to details indicated on the Drawings.

C. Inlets and Junction Boxes: Construct inlets and junction boxes of the materials and to the exact dimensions and grades shown on the Drawings. Finish surfaces smooth and true. Expansion joint filler shall be preformed bituminous treated fiberboard conforming to ASTM D 994, Type III.

D. Pumps:

1. Basin to be cleaned thoroughly, with all water and debris removed prior to installing pumps.
2. Pumps shall be installed and assembled per manufacturer's instructions.

### 3.5 FIELD QUALITY CONTROL

A. Contractor Checking and Inspection:

1. Storm Drains
  - a. General. Work performed and materials furnished and installed, as shown on the Drawings or required by the Specifications, shall be subject to review by the Contractor. Provide Owner's Representative with unrestricted access to the Work during construction to allow him the opportunity to review materials and workmanship. Comply with Div 01.
  - b. The storm drain pipe shall be checked by the Contractor when backfill has reached the top of the pipe. Both internal and external inspections for alignments shall be made at this time. The Sub-Contractor shall correct at his



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expense, to the Contractors' satisfaction, any section of the line found to be unsatisfactory in material, alignment, grade, or joints.

3.6 ADJUSTMENT AND CLEANING

- A. Pavement Repair:
  - 1. Where necessary to cut pavements, drives, sidewalks or other permanent surfaces, the cuts shall be made with neat lines at least 1 foot wider than the trench. Cut material shall be disposed of by Contractor.
    - a. The surfaces that are cut shall be restored to the condition specified before the cut was made. Keep streets open for use and also keep portions of driveways open for use.
  - 2. Concrete for repair work shall be as specified in Section 32 13 13, Sitework Concrete. Concrete shall be finished to match surrounding surfaces.
  - 3. Asphaltic concrete for repair work shall be as specified in Section 32 12 16, Asphalt Concrete Pavement.

3.7 FINAL ACCEPTANCE

- A. Final acceptance of the project shall be contingent upon the satisfactory completion of backfilling, surface repairs, passage of final tests and furnishing "as-builts" Record Drawings showing any deviations from the Drawings.
- B. The Sub-Contractor shall be liable for any failure of storm drain or sanitary sewer facilities installed by him for a period of one year after the date of final acceptance.

END OF SECTION



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SECTION 334600 - SUBDRAINAGE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
  - 1. Perforated-wall pipe and fittings.
  - 2. Geotextile filter fabrics.

1.03 ACTION SUBMITTALS

- A. Product Data:
  - 1. Perforated PVC pipe
  - 2. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.01 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PVC Sewer Pipe and Fittings: ASTM D2729, bell-and-spigot ends, for loose joints.

2.02 SOIL MATERIALS

- A. Soil materials are specified in Section 31 23 00 "Earthwork."

2.03 GEOTEXTILE FILTER FABRICS

- A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D4491.



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B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Survivability: AASHTO **M 288 Class 2**.
2. Styles: Flat and sock.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 23 33 "Trenching, Backfilling, and Compaction."

#### 3.03 LANDSCAPING DRAINAGE INSTALLATION

- A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with adhesive.
- E. Add drainage course to top of drainage conduits.
- F. After satisfactory testing, cover drainage conduit to within 12 inches of finish grade.



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- G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.
- I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

#### 3.04 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
  - 1. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches unless otherwise indicated.
  - 2. Lay perforated pipe with perforations down.
  - 3. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install thermoplastic piping according to ASTM D2321.

#### 3.05 PIPE JOINT CONSTRUCTION

- A. Join perforated PVC sewer pipe and fittings according to ASTM D3212 with loose bell-and-spigot, push-on joints.
- B. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

#### 3.06 CLEANOUT INSTALLATION

- A. Comply with requirements for cleanouts specified in Section 33 40 00 "Storm Drain Piping and Appurtenances."
- B. Cleanouts for Landscaping Subdrainage:



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1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches deep. Set top of cleanout flush with grade.
3. In nonvehicular-traffic areas, use NPS 4 PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches deep. Set top of cleanout 2 inches above grade.
4. Comply with requirements for concrete specified in Section 03 30 00 "Cast-in-Place Concrete."

3.07 CONNECTIONS

- A. Comply with requirements for piping specified in Section 33 40 00 "Storm Drain Piping and Appurtenances." Drawings indicate general arrangement of piping, fittings, and specialties.

3.08 IDENTIFICATION

- A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 31 23 00 "Earthwork."
  1. Install PE warning tape or detectable warning tape over ferrous piping.
  2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.09 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
  2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.
- B. Drain piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.



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3.10 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 33 46 00