Project Manual
Volume 2 of 2

Fontana City Hall – Phase II

8353 Sierra Avenue,
Fontana, CA 92335

SILLMAN Project Number: 24013

BID SET

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Developed for:

SILLMAN

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PRIVATE FIRE MAIN SYSTEM

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work includes but is not necessarily limited to that shown on the approved plans and requirements of this section.

B. Private site fire water system shall include the following:

1. Connection of private fire main system to lateral(s) at property line(s), as shown on approved plans.

2. Approved backflow prevention assembly or assemblies.

3. All on-site pipe, fittings, valves, hydrants and appurtenances as shown on the approved plans.

4. Location and configurations of fire department connections as approved by responding fire agency.

5. Building system service entry at each riser room.

6. All tests, flushing, inspections and sanitation treatments as required to obtain approval by all authorities having jurisdiction including local fire authority, serving water department and Inspector of Record.

7. Fees, permits, inspections and tests.

8. Meetings and correspondence with project team members and authorities having jurisdiction to confirm specific requirements for this project, including:
   a. Locations and methods of discharging water from tests and flushing.
   b. Requirements for pipe and fitting exposure to facilitate visual inspections.

C. Refer to Section 21 13 13 "Wet-Pipe Fire Sprinkler System" for interior building systems work that is not a part of this section.

1.2 RELATED WORK IN OTHER SECTIONS

A.	Submittals	Division 01
B.	Tests and Inspections	Division 01
C.	Contract Closeout	Division 01
D.	Painting	Section 09 91 23
E.	Wet-Pipe Fire Sprinkler Systems	Section 21 13 13
F.	Sanitary Waste Piping Specialties	Section 22 13 19
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1.3 QUALITY ASSURANCE

A. Manufacturers Qualifications: Firms regularly engaged in manufacture of listed and/or approved fire protection water system equipment and accessories of types, materials, and

sizes required and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with fire water work similar to that required for project.

C. Prior to acceptance of the work on private property, obtain/verify acceptance of all work in the public domain from the serving utility and submit copies of the Certificates of Completion to the inspector and owner.

1.4 CODES AND STANDARDS

A. In addition to complying with all pertinent standards, codes and regulations, comply with all requirements of:

1. California Building Code, 2022 edition.
2. California Fire Code, 2022 edition.
3. Serving Local Fire Authority requirements.
4. Serving Local Water Utilities Department requirements.
5. NFPA 13, 24, 25 and 72 (as adopted by the State of California).
6. Underwriters Laboratories (UL) and FM Global (FM) listed products.
7. American Water Works Association (AWWA) requirements and specifications.

B. Other Referenced Standards:

Unless otherwise noted on the plans, all work shall conform to the following standard specifications and drawings:

1. Standard Specifications:
   a. Standard Specifications for Public Works Construction, current Edition.
   b. City of Fontana Guidelines and Standards, current edition.
   c. California Dept. of Transportation, "Manual of Traffic Controls for Construction and Maintenance Work Zones", California MUTCD, 2014 ed.
   d. City of Fontana Cross-Connection Control and Backflow Prevention Programs.

2. Standard Drawings:
   a. City of Fontana Standard Drawings For Public Works Construction.

1.5 SUBMITTALS

A. Submit materials data sheets for all proposed product substitutions from the approved plans and data sheets. A statement of equivalency shall accompany items that are not exactly comparable to the approved product. Proposed substitutions of backflow assemblies shall only be allowed if submitted to and approved by Fire Life Safety review with all required hydraulic calculations for any additional pressure loss. Such substitutions shall be at the contractor’s risk and at no additional expense to the owner.

B. Record Drawings: At project closeout, submit record drawings of installed fire water system piping and products, in accordance with requirements of Division 1.

C. Maintenance Data: Submit maintenance data and parts lists for fire water system materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division 01

1.6 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by District or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Owner or Construction Manager no fewer than five days in advance of proposed interruption of service.

2. Do not proceed with interruption of water-distribution service without Owner or Construction Manager's written permission.

PART 2 – PRODUCTS

2.1 IDENTIFICATION

A. Underground-Type Plastic Line Marker: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 3" wide x 4 mils thick. Provide tape with printing reading "CAUTION BURIED WATER LINE BELOW" (or similar language).

2.2 PIPE AND PIPE FITTINGS – GENERAL

A. Provide ells, tees, reducing tees, couplings, and other required piping accessories of same type and class of material as conduit, or of material having equal or superior physical and chemical properties as acceptable to Owner's Architect/Engineer and Inspector.

B. Joints for pipe shall be push-on joints as specified in ASTM D 3139. Joints between pipe and metal fittings, valves, and other accessories shall be push-on joints as specified in ASTM D 3139, or shall be compression-type joints/mechanical-joints as respectively specified in ASTM D 3139 and AWWA C111. Each joint connection shall be provided with an elastomeric gasket suitable for the bell or coupling with which it is to be used.

1. Gaskets for push-on joints and compression-type joints/mechanical-joints for joint connections between pipes and metal fittings, valves, and other accessories shall be as specified in AWWA C111 respectively for push-on joints and mechanical-joints.

2. Mechanically coupled joints, using a sleeve-type mechanical coupling, may be used as an optional jointing method in lieu of push-on joints on plain-end PVC plastic pipe.

2.3 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

B. Hard Copper Tube: ASTM B 88, Type K or Type L, water tube, drawn temper.

1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy

or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

C. Bronze Flanges: ASME B16.24, Class 150, 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.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

2. Gaskets: AWWA C111, rubber.

C. Flanges: ASME 16.1, Class 125, cast iron.

2.5 PVC PIPE AND FITTINGS

A. PVC, AWWA Pipe: AWWA C900 bell end with gasket and with spigot end, Pressure Class 150/235 (DR 18) with cast- iron-pipe-equivalent OD. Where pressures may exceed 175 PSI, pipe shall be Pressure Class 200/305 (DR 14).

1. Comply with UL 1285 for fire-service mains as applicable and/or required.

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.

3. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   a. Gaskets: AWWA C111, rubber.

2.6 POLYETHYLENE PIPE AND FITTINGS

A. PE, ASTM Pipe: ASTM D 2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 160 psig.

1. Insert Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.

2. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

B. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than 200 psig.

1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 200 psig.

C. PE, Fire-Service Pipe: ASTM F 714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG Class 200.

1. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

2.7 Chlorinated Polyvinyl Chloride FIRE PROTECTION PIPE AND FITTINGS

A. CPVC, listed for fire protection per UL 1821.

2.8 TRANSITION FITTINGS

A. One-piece riser sweep, 90° fabricated 304 stainless steel.

1. UL and/or FM approved for fire protection services.
2. Working pressure rating 200 PSI minimum, equivalent to DR 14.
3. Vertical end per AWWA C606 for roll groove and C-207 for flanged pipe.
4. Horizontal end per AWWA C900 and standard ductile iron pipe diameters with UL 157 gasket.

2.9 GATE VALVES

A. Provide flanged or mechanical joint gate valves, listed for fire protection service, 175 psi working pressure for 12" and smaller, 150 psi for sizes larger than 12".

1. Non-rising-Stem, Resilient-Seated Gate Valves
   a. Description: Ductile-iron body and bonnet; with bronze gate, resilient seats, bronze stem, and stem nut.
   b. Standard: AWWA C509. Minimum Pressure Rating: 250 psig.
   c. End Connections: Push on or mechanical joint.
   d. Interior Coating: Complying with AWWA C550.

2. OS&Y, Rising-Stem Gate Valves
   a. Description: Ductile-iron body and bonnet, with bronze gate, resilient seats, and bronze stem.
   b. UL 262, FM approved. Minimum Pressure Rating: 175 psig.
   c. End Connections: Flanged.

B. 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. Post shall be listed for use with specific make/model of gate valve.

C. Valve Box and Cap: Telescopic barrel type for use with underground gate valves, cap is to be cast iron and marked "WATER".

2.10 BACKFLOW PREVENTION ASSEMBLY

A. Backflow preventer assembly shall be installed strictly per all requirements and standard drawings of serving water authority. Assembly shall be Reduced Pressure Detector Assembly (RPDA) with bypass and meter as required.

B. Any proposed assembly shall be U.L. classified and/or FM approved for fire protection service and shall be listed by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California.) Verify exact make and model of appliance with serving water authority.

2.11 CHECK VALVES

A. Check valves shall be iron body, bronze mounted, horizontal swing check. As acceptable to authorities having jurisdiction, iron body, bronze, disk wafer check may be used.

B. Check valve shall be U.L/F.M. approved for fire protection use, and recommended by the manufacturer for direct bury where such installation is to be required.

1. Where check valve is installed underground, an approved valve box or other means of accessing the valve for inspections and testing shall be furnished and installed.

C. Iron body, bronze disk threaded or grooved swing check may be installed at Fire Department Connection, and located as acceptable to serving fire department.

2.12 FIRE HYDRANTS

A. General: Hydrants shall conform to serving fire department requirements. Number of hydrants, spacing and proximity to fire apparatus lanes shall be in accordance with approved plans.

B. Hydrants shall be wet-barrel type except where subject to freezing.

C. Hydrants shall be furnished with National Standard (fire hose) Threads (NST). Unless noted otherwise there shall be two 4” and one 2½” ports, individually valved and equipped with caps and chains.

2.13 FIRE DEPARTMENT CONNECTIONS

A. Furnish 4" x 2 1/2" two-way, Siamese fire department connection. Finish and model shall be in conformance with serving fire department requirements. Provide check valve per Section 2.11.

B. Fire department connection piping shall be ductile iron, with corrosion protection as specified in this section. No steel piping shall be installed at fire department connections.

2.14 ANCHORAGES

A. General: Provide anchorages for ells, tees, crosses, plugs, caps, bends, valves, and hydrants. After installation, apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of ferrous anchorages.

1. Clamps, Straps and Washers: Steel, ASTM A 506.

2. Rods: Steel, ASTM A 575.
3. Rod Couplings: Malleable-iron, ASTM A 197.
4. Bolts: Steel, ASTM A 307.
5. Cast-Iron Washers: Gray-iron, ASTM A 126.
6. Thrust Blocks: Concrete, minimum 2,500 psi

2.15 CORROSION PROTECTION

A. Encasement for Underground Metal Piping:

1. Standards: ASTM A 674 or AWWA C105.

2. Form: Sheet or tube.

3. Material: LLDPE film of 0.008-inch minimum thickness.

4. Material: LLDPE film of 0.008-inch minimum thickness, or high-density, cross-laminated PE film of 0.004-inch minimum thickness.

5. Material: High-density, cross-laminated PE film of 0.004-inch minimum thickness.

6. Color: Black.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
   a. Standard: ASSE 1079.
   b. Pressure Rating: 250 psig.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.
   d. Flanges in first subparagraph below are available in at least NPS 1-1/2 to NPS 4.
3. Dielectric Flanges:
   a. Standard: ASSE 1079.
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 150 psig or 300 psig.
   d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:
   a. Field-assembled companion-flange assembly, full face or ring type.
   b. Non-conducting materials for field assembly of companion flanges.
   c. Pressure Rating: 150 psig or 300 psig.
   d. Gasket: Neoprene or phenolic.
   e. Bolt Sleeves: Phenolic or polyethylene.
   f. Washers: Phenolic with steel backing washers.

5. Dielectric Couplings:
   a. Galvanized steel couplings with inert and noncorrosive thermoplastic lining, with threaded ends.
   b. Pressure Rating: 300 psig.

6. Dielectric Nipples:

a. Standard: IAPMO PS 66.
b. Electroplated steel nipple complying with ASTM F 1545.
c. Pressure Rating: 300 psig at 225 deg F minimum.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

2.16 ELECTRONIC SUPERVISION

A. Furnish valve supervision, as required by authorities having jurisdiction, at all valves controlling fire protection water supplies, and any required underground conduit thereto.

B. Provide UL/FM approved tamper switch, Model PIVSU-A1, or OSYSU-A1, or UL/FM listed equivalent, 12 or 24 VDC or 120VAC with one set of Form C, single pole, double-throw contacts.

C. Tamper connections shall be furnished and zoned as required by serving fire department.

D. Signals shall be monitored at local fire alarm panel and central station as required and as shown on fire alarm plans.

PART 3 – EXECUTION

3.1 INSTALLATION OF IDENTIFICATION

A. General: During back-filling/top-soiling of underground fire water piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished subgrade, but at least 6" above the top of pipe.

3.2 INSTALLATION OF PIPE AND PIPE FITTINGS

A. General: Install exterior fire water systems in compliance with applicable provisions of NFPA 24 and the Standard Specifications for Public Works Construction.

B. Polyvinyl Chloride Pipe: Install in accordance with manufacturer's installation instructions.

C. Depth of Cover: Provide three (3) foot minimum depth of cover over underground piping.

D. Transition from underground to interior building system the passes under footings and on-grade slab shall utilize a one-piece riser sweep.

1. Pipe and fittings shall be installed so that no mechanical joints are located below structural footing or slab on grade.
2. All penetrations of floors and walls shall maintain minimum 2” annular clearance around entire circumference of piping.
3. All piping shall be restrained using mechanical joint fittings, rods and/or thrust blocks.
4. All pipe and fittings shall be protected from corrosion as specified in this section.

3.3 INSTALLATION OF VALVES

A. General: Install valves as indicated. Provide post indicator for control valves where shown on plans.

B. Control Valves: Install post indicator valve at each connection into building, locate 40' from building outside wall, or as shown on approved plans.

C. Shutoff Valves: Install shutoff valve ahead of each hydrant.

3.4 CONCRETE PADS

A. As required by serving fire and/or water department, furnish concrete pads under all fire hydrants, backflow prevention assemblies and fire service valve assemblies per standard drawings and details.

1. Where pipe, fittings and devices are installed in the horizontal position, furnish approved pipe stands or other means of support.

3.5 SIGNAGE

A. Provide signage as required by serving fire department to identify all fire protection system valves and fire department inlet connections. Signs shall be building and system specific and shall be constructed of durable, weather-resistant materials and shall be finished or coated or otherwise protected as required to prevent damage and fading from ultra-violet light.

1. As required by serving fire authority, signage shall be affixed to valves and inlet connections using lightweight chain with zinc or galvanized finish.
2. Lettering shall be of the minimum size and color required by serving fire department.
3. Where required, signage shall be installed on posts and elevated above finished grade.

3.6 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered, and after thrust blocks have sufficiently hardened. Fill pipeline with water 24-hrs prior to testing, and apply test pressure to stabilize system.

B. Hydrostatic Tests: Test at not less than 200 psi for 2 hours, or at 50 psi above maximum static pressure where greater than 150 psi.

1. Test shall be considered a fail if leakage exceeds allowable as prescribed in NFPA 24, or as required by authorities having jurisdiction.
2. Increase pressure in 50 psi increments and inspect each joint between increments. Hold at test pressure for one hour, decrease to 0 psi. Slowly increase again to test pressure and hold for one more hour.

C. Upon acceptance of hydrostatic testing by DSA Inspector of Record, the entire fire main system shall be flushed in accordance with the procedures described in NFPA 24. Flow rates shall be as required by NFPA 24, or at the hydraulically calculated water demand rate of the system, whichever is greater.

1. Erosion and storm drain controls, conformance to local best practices and the collection/treatment of discharge as required shall be the responsibility of this contractor.

D. Operating Tests: Open and close all valves and hydrants under system water pressure. Order required operational tests by serving Fire and Water Departments.

3.7 COMPLETION

A. Closeout

1. Upon completion and approval of system, and prior to occupancy, provide instruction to the Owner, or Owner's representative, in all details of system operation and maintenance. Prepare and submit maintenance and operation manual per other sections of specifications as applicable.
2. Provide three copies of final inspection and certification as prescribed by Owner's Insurance Underwriter, and other authorities having jurisdiction.
3. Furnish fully executed NFPA Materials and Test Certificate to Owner or Owner's representative, local fire authority, architect and to DSA Inspector of Record.
4. Submit two copies of guarantee per Division 01.
5. Provide three (3) copies of system "As-Built" drawings to the Owner or Owner's representative. Drawings shall show actual installation details including all piping and equipment locations, room or facilities modifications, etc. One (1) copy of drawings shall be on reproducible type media.

B. Clean Up

1. Equipment, appurtenances, fixtures and exposed piping shall be clean, and all excess dope and oil shall be removed. Sprinkler heads shall be cleaned without the use of any solvents.
2. Upon completion of work, remove all surplus material, debris, and equipment associated with or used in the execution of this work. Sweep work and storage areas, as required, to remove metal shavings and oily residue.

END OF SECTION 21 11 19

SECTION 21 13 13

WET-PIPE FIRE SPRINKLER SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work includes, but is not necessarily limited to, the following work areas:

1. Design & installation of wet-pipe automatic fire sprinkler system including all interior areas, breezeways, exterior soffits and combustible or accessible concealed spaces.
2. Maintaining updated record drawings, including all field changes and as-built conditions.
3. Connection of interior fire suppression system to underground site fire service lateral, at point of connection shown on fire protection and civil site plans.
4. Test valves, drain lines, and all other inspection components.
5. All coring, drilling and structural work required for piping installation, as approved by Architect.
6. Local audible alarm and connection points for central station monitoring.
7. Fees, permits, inspections and tests.
8. Meetings and correspondence with project team members to confirm specific requirements for this project, including:
   a. Location and methods of discharging water from test and drain connections.
   b. Zoning and signaling requirements for alarm, detection and monitoring systems.

1.02 RELATED WORK IN OTHER SECTIONS

A.	Submittals	Division 01
B.	Tests and Inspections	Division 01
C.	Contract Closeout	Division 01
D.	Painting	Section 09 91 23
E.	Site Fire Protection Water Distribution	Section 21 11 19
F.	Plumbing (Drainage)	Section 22 13 19
G.	Fire Detection and Alarm	Division 28

1.03 QUALITY ASSURANCE

A. Qualifications of Fabricators and Installers

1. For actual fabrication and installation of sprinkler systems, use only personnel who are thoroughly trained and experienced with the products involved, and in the recommended methods of their installation.

2. Installing contractor shall have a California C-16 license and shall be experienced in design and installation of systems in projects of similar size and scope.

1.04 REFERENCES

A. Comply with all pertinent standards, codes and regulations including all requirements of:

1. California Building Code, 2022 ed.

2. California Fire Code, 2022 ed.

3. City of Fontana Fire Department requirements.

4. City of Fontana Water Department requirements.

5. NFPA 13, 24 and 72, as adopted.

6. Underwriters Laboratories (UL), FM Global (FM) and ICC Evaluation Service (ICC)

1.05 SUBMITTALS

A. Shop Drawings

1. Within 30 days after award of Contract, and per Division 01, submit coordinated shop drawings to the Architect for review. Shop drawings shall be submitted to the architect for review prior to submittal to City of Fontana or other jurisdictional authorities. A complete submittal shall be in accordance with NFPA 13, Chapter 28 and include all of the following:

a. Principle dimensions, including tie-in to water main at point of connection, interior riser and details of construction.

b. Location of all switches, bells and electrical connections for alarm system, as described in this specification.

c. Location of connections to drain receptors for test and drain discharge.

d. Location of all beams, soffits, skylights and other structural and/or architectural features that may affect or impact the design or installation of fire protection systems.

e. Hydraulic calculations for fire sprinkler system, formatted to meet the requirements of NFPA 13, Chapter 28 and acceptable to all authorities having jurisdiction. Computer programs that locate the most remote area(s) shall include at least two shifted design areas in the calculation worksheets.

f. Calculation of all seismic bracing loads. Where applicable or required by the structural engineer of record, proof of coordination at points of connection for all seismic braces shall be furnished.

g. Notations and identifying marks for fabrication and stock-listing may be included.

2. With plans and calculations, submit materials data sheets for all operational and primary system components, including but not limited to backflow prevention devices, valves, piping, fittings, grooved couplings, hangers, bracing and sprinklers.

B. Maintenance Manual

1. Submit maintenance manual per requirements of Division 1, fully describing inspection, testing & maintenance schedules, replacement parts, and other operation requirements.

C. Guarantee

1. Contractor shall guarantee fixed fire protection system, for a period of two years after date of final inspection, from leaks and other failures from materials and workmanship. Guarantee shall include repair of damage to Owner and/or tenants and conform to requirements of Division 1.

1.06 COORDINATION

A. Coordinate work with that specified in other sections before start of installation. Any installation found to be in conflict with such work as a result of neglected coordination, shall be removed and reinstalled in new locations designated by the Architect at no additional expense to the Owner.

B. Contractor shall contact the Architect and obtain necessary information to design fire sprinkler system to fit into allotted spaces without interfering with work by other trades.

C. Coordinate with Plumbing section for size and location of drain receptors, where required or shown for draining and testing fire sprinkler risers and systems. All drain piping shall discharge into the receptors and not through walls or curbs, unless noted otherwise.

PART 2 - DESIGN AND MATERIALS

2.01 GENERAL DESIGN CRITERIA

A. Coverage and Scope

1. All storage areas shall be protected for Ordinary Hazard, Group 2. System shall discharge a minimum density of .20 gpm/sq. ft. over the most remote 1500 sq. ft., with 250 GPM hose stream allowance. Spray sprinklers shall be spaced at a maximum of 130 sq. ft. per sprinkler, or as specified in 2.03 (E.1).

2. Kitchen, janitorial and utility areas shall be protected for Ordinary Hazard, Group 1. System shall discharge a minimum density of .15 gpm/sq. ft. over the most remote 1500 sq. ft., with 250 GPM hose stream allowance. Spray sprinklers shall be spaced at a maximum of 130 sq. ft. per sprinkler, or as specified in 2.03 (E.1).

3. All other areas, shall be designed for Light Hazard. System shall discharge a minimum density of .10 gpm/sq. ft. over the most remote 1500 sq. ft., with 100 GPM hose stream allowance. Spray sprinklers shall be spaced at a maximum of 225 sq. ft. per sprinkler, or as specified in 2.03 (E.1).

B. Water Flow Test Data

1. Water supply data for system design shall be determined using current (within one year of submittal to authorities having jurisdiction) flow test information. Contractor shall obtain and verify flows, static and residual pressures and related hydraulic data. Fees to obtain this information shall be paid by Contractor. Data used for system design must conform to actual on-site conditions at time of final inspection. This information is subject to verification by Owner and all authorities having jurisdiction.

2. Static and residual pressures from physical flow testing shall be reduced by a minimum of 10% below actual water supply data. As required by authorities having jurisdiction, fire flow data obtained by flow modeling shall be reduced by the specified margin.

2.02 MATERIALS AND PRODUCTS – GENERAL

A. All material installed shall be approved and/or listed for fire protection use by the referenced authorities, codes and standards. All material shall be new and without field modifications. Where semi-recessed sprinklers are installed on a painted or stained surface, escutcheons shall be field painted to match adjacent finish.

2.03 SPRINKLERS

A. General

1. All sprinklers shall be of similar make and appearance and shall have the same bulb or link and finish except where otherwise required by exposure to heat sources, freezing temperatures, corrosive environment, etc.

B. Interior Ceilings and Exterior Soffits

1. Furnish fully concealed recessed standard spray pendent, bulb or fusible link type, with factory finished cover plate as specified by Architect.

2. Corrosion-resistant lead finish sprinklers shall be installed at exterior areas. Color and finish of all corrosion-resistant sprinklers shall be UL/FM approved and coordinated with Architect.

C. Exterior Overhangs

1. Furnish extended coverage sidewall sprinkler, with semi-recessed escutcheon that allows installation on an angle parallel to the slope, Viking VK 606 or equal.

2. Sprinklers shall be corrosion-resistant lead finish.

3. Cover plates shall be white or chrome factory finish as directed by Architect.

D. Concealed Areas, Unfinished Ceilings, and Service Areas

1. Provide standard spray upright or pendent, with rough brass finish.

2. Where required, escutcheons shall be recessed, with white painted finish. Use two-piece, style #401 with chrome finish where surface-mounted lighting or other accessory components could obstruct sprinklers.

E. Extended Coverage Sprinklers

1. Listed extended coverage sprinklers may be used in lieu of 2.3 (B), (C) and (D) above, subject to Architect's review and approval.

2. Extended coverage sprinklers shall be calculated to provide minimum densities as required in 2.1 (A) and also as required by the terms of the listing and manufacturer's data sheet. Minimum starting pressure, minimum and maximum spacing requirements and clearances from obstructions shall be noted and observed.

3. Finishes and escutcheons shall be as described in 2.3 (B), (C) and (D) above.

F. Temperature Ratings and Response Type

1. Sprinklers below finished ceilings, and in all other occupied areas shall have a temperature rating of Ordinary (155-165° F), except as noted below.

2. Sprinklers in unventilated spaces shall have a temperature rating of Intermediate (200-212° F), unless otherwise required by code.

3. Sprinklers within zone of influence of space heaters or other heat-producing equipment shall have a temperature rating of High (250-300° F), unless otherwise required by code.

4. All sprinklers shall be listed, quick-response type, unless high or very high temperature sprinklers are required.

2.04 HANGERS AND SUPPORTS

A. General

1. Provide hangers approved by UL/FM and/or ICC, and in accordance with NFPA 13 for fire sprinkler systems. Shop-fabricated supports shall be designed to meet requirements of NFPA 13, and must be certified by a registered professional engineer.

2. Provide earthquake bracing approved by UL/FM, NFPA 13 and ASCE 7. Locations of all bracing shall be clearly shown on shop drawings. All bracing shall be assembled, calculated and installed per NFPA 13, Chapter 18. All calculations shall be shown on shop drawings or included in the materials submittal package.

3. Size all anchors and fasteners per NFPA 13. All lag screws, bolts and drive screws shall be installed as required by codes and accepted good practices. Pilot holes shall be drilled in wood framing members as required by Architect's structural engineer.

4. All fasteners and/or anchors proposed for use in concrete construction shall be specifically listed and approved for use on fire sprinkler systems in seismic zones. Powder-driven studs shall not be used unless all system components including installation tool and pins are listed.

2.05 INTERIOR SPRINKLER PIPE AND FITTINGS

A. General

1. All pipe and fittings shall be new, acceptable to authorities having jurisdiction, per all applicable standards and codes, and free from damage and distortion.

B. Product Characteristics

1. Black steel Schedule 40, ASTM A-53/135/795, for all piping with threaded joints.
2. Black steel Schedule 10, ASTM A-53/135/795, for all piping, with non-threaded joints.
3. Threaded fittings shall be of cast or malleable iron, class 125 or 150, conforming to ANSI B16.3 and ANSI B16.4.
4. Flanged fittings shall be provided where required. Flanges shall be of cast iron, class 125, conforming to ANSI B16.1.
5. Shop-welded fittings shall be of wrought steel, conforming to ANSI B16.9. No field welding of fire sprinkler piping will be allowed.
6. One-piece reducing fittings shall be used wherever a change is made in pipe size. Bushings shall not be used, except where fittings of the required size are not available.
7. Grooved thinwall steel pipe connections shall be made using a UL/FM approved ductile iron coupling, with rubber gasket. Installation shall be per manufacturer's instructions.
8. All piping shall be joined with welded, threaded or grooved fittings. Fittings for hole cut connections are not acceptable.

2.06 ACCESSORY CABINET

A. Provide metal sprinkler cabinet for a reserve supply of sprinklers, as required by NFPA 13. Include one suitable head wrench for each type of sprinkler installed. Stock shall include all types and temperature ratings installed. Locate as directed by Architect.

2.07 SIGNS

A. Provide metal signs, permanently marked to show function, for all valves, controls and related assemblies. Locate as required by codes and authorities having jurisdiction. Where signs are necessary to identify valves or assemblies in hidden or void spaces, locate as directed by Architect.

2.08 PROTECTION OF SPRINKLERS

A. Provide UL/FM listed guards for sprinkler heads located in areas susceptible to mechanical damage.

2.09 ESCUTCHEON PLATES

A. Provide chrome-plated escutcheons where piping penetrations are made through finished walls and ceilings. Plates shall be painted to resist corrosion when exterior installation is required.

2.10 LOCAL ALARM COMPONENTS

A. Exterior Alarm Bell

1. Furnish 10" diameter, UL/FM approved bell with identification sign, rated 24 VDC, with standard mounting hardware.
2. Locate where required by authorities having jurisdiction, and as acceptable to Architect.

B. Water Flow Switch

1. Furnish water flow alarm switch at the main system riser.

2. Provide UL/FM approved, with two sets of Form C, single pole, double throw contacts, and adjustable retard feature.

3. Retard shall be set by Contractor so as to prevent false alarms, and still allow audible alarm within 30 seconds.

2.11 CENTRAL STATION SUPERVISION

A. General

1. Furnish supervisory switches at all valves controlling fire protection water supplies, and any required underground conduit thereto.

2. Provide UL/FM approved tamper switch, Model PCVS-1 or OSYSU-1 or equal, 24 VDC with one set of Form C, single-pole, double-throw contacts.

2.12 VALVE COMPONENTS

A. Control Valve

1. Sprinkler system shall be controlled by valves at the backflow assembly and the post indicator valve shown on civil plans.

B. Check Valves

1. Check valves shall be iron body, bronze mounted, horizontal swing check.

2. Check valve shall be U.L/FM approved for fire protection use, and recommended by the manufacturer for direct bury where such installation is to be required.

3. Iron body, bronze disk threaded or grooved swing check may be installed at Fire Department Connection, and located as acceptable to serving fire department.

4. Check valve installation shall be as required by serving fire department.

C. Interior Drain/Test Valves

1. Provide listed combination test and drain valve with integral pressure relief bypass, rated minimum 175psi working pressure.

2.13 UNDERGROUND PIPE AND FITTINGS

A. General

1. All pipe and fittings shall be new, acceptable to authorities having jurisdiction, comply with all applicable standards and codes, and free from damage and distortion.

B. Product Characteristics

1. Pipe shall be cast or ductile iron, or C-900 PVC, as shown on plans or required by water department. Pipe under structural footings shall be cast or ductile iron only, to a distance of at least 5'-0" beyond outside face of building.

2. Fittings shall be ductile iron, class 250, flanged or mechanical joints as required. Thrust restraint shall be provided per NFPA 24 and approved

plans. Contractor shall make a complete materials submittal for all underground materials.

C. All ferrous components shall be coated with corrosion-resistant material such as non-oxide grease, and enveloped with seamless polyethylene sleeve material.

PART 3 - EXECUTION

3.01 JOB SITE CONDITIONS

A. Inspection

1. Prior to all work of this section carefully inspect the installed work of other sections, and verify that all such work is complete to the point where this portion of the work may properly commence in accordance with all submittals, designs, and applicable codes.

B. Discrepancies

1. In the event of a discrepancy, immediately notify the Architect. Do not proceed with installation in areas of discrepancy until all such discrepancies and/or omissions have been fully reviewed and clarified.

3.02 FABRICATION

A. General

1. All pipe, fittings, and materials shall be prepared by qualified personnel, trained and experienced with the products involved, and the recommended methods of preparation.

2. All pipe cuts, threads, and grooves shall be made according to applicable codes, standards and accepted good practices.

3. Pipe shall be free of damage, flaws and burrs. Threads and grooves shall not be excessively shallow or deep.

4. Fittings shall be made onto the pipe no tighter than necessary. Cracked or broken fittings shall be replaced, without exception.

5. Excess dope and oils shall be removed before shipment to job site.

B. Shop Welding

1. Welding methods shall comply with NFPA 13 and AWS B2.1. Contractor shall be responsible for all welded joints and any qualifying procedures for welders and related personnel. Field welding of sprinkler piping will not be allowed.

2. Holes in pipe for outlets shall be cut to full inside diameter of fitting, prior to welding in place. Holes shall be free of slag and welding residue and of smooth continuous bore. Fittings shall not penetrate internal diameter of run piping. Holes shall be cut by hole-saw, plasma or rotary bit. Torch-cutting of holes is strictly prohibited.

3. All welded pipe shall be subject to inspection by Inspector of Record or other jurisdictional authority before it is installed. Where required, provide documentation of acceptance at project close-out.

3.03 INSTALLATION

General

1. All installations shall be per referenced standards. Follow manufacturer's directions and recommendations in all cases as required for all approvals and warranty enforcement.

2. All cutting of structure shall be subject to approval by the Architect. Beams, decks and other structural components shall not be cut or altered in any way unless previously approved.

3. Provide flexible couplings where required to provide expansion capability, and for earthquake protection per NFPA 13. Provide sway bracing as required by coupling locations.

4. Entire sprinkler system shall be installed in such a manner so that it can be drained in accordance with NFPA 13. Drains shall be located at suitable points as approved by Architect. No primary or auxiliary drain shall be located in any public area or electrical room. All drains shall discharge into dedicated receptors.

5. No work shall be covered or enclosed until inspected, tested, and approved by Architect and/or authority having jurisdiction. Should any work be concealed before inspection, the Contractor shall, at Contractor's expense, uncover such work and after it has been inspected, tested and approved, provide for all repairs as may be necessary to restore work to original and proper condition.

6. Sprinklers at finished ceilings and in exposed locations shall form a symmetrical pattern and shall be located at the exact centerline of 2' square ceiling tiles and "Second Look" tile modules. Where 2' x 4' ceilings occur, sprinklers shall be centered in the 2' direction with escutcheons at least 6" clear of ceiling T-bars.

7. Sprinkler layout shall accommodate lighting and HVAC register locations. Coordination with the work of these sections is the responsibility of Contractor.

8. Without exception, no piping shall be run under or through any skylight or skylight well. Any additional upright or pendent sprinklers, which may be required by skylight locations, shall be the responsibility of this contractor.

9. All penetrations of wall and floor assemblies shall be suitably sleeved, patched and/or sealed in order to preserve fire rating, where applicable.

10. Location of control valves, fire department connection, and inspector's test shall be as required by authorities having jurisdiction, and as approved by Architect.

11. Local alarm bell shall be located so that it can be easily heard and seen by passersby and fire department personnel. Locate on exterior wall, 10'-0" above finished grade, as approved by Architect.

12. Provide wood or metal floor pans under and around pipe cutting/threading machines, in designated work areas, to protect floor surfaces from damage and discoloration.

13. Paint all fire sprinkler piping risers, drops and other components exposed to view in final construction as directed by Architect and per Section 09912.

14. Underground pipe and fittings shall be installed per NFPA 24, and applicable local codes and standards. Trenching, back-filling, depth of bury and size, shape and location of all thrust blocks shall be acceptable to all jurisdictional agencies.

3.04 FIELD QUALITY CONTROL

A. Perform all tests as required by NFPA 13, California Fire Code and all authorities having jurisdiction in addition to requirements of Division 1. Maintain an accurate record of all tests and inspections on the job site, including date of test and inspecting agency.

B. Before connection of interior system to underground main, underground piping shall be hydrostatically tested, flushed and accepted by authorities having jurisdiction. Provide documentation of acceptance by jurisdictional authority and NFPA 13 “Contractors Material & Test Certificate for Underground Piping”. All required health and bacterial tests shall be the responsibility of Contractor.

3.05 COMPLETION

A. Closeout

1. Upon completion and approval of system, and prior to occupancy, provide instruction to the Owner, or Owner's representative, in all details of system operation and maintenance. Prepare and submit maintenance and operation manual per Division 1.

2. Provide three copies of final inspection and certification as prescribed by jurisdictional authority, and NFPA 13 “Contractors Material & Test Certificate for Aboveground Piping”

3. Provide three (3) copies of system "As-Built" drawings to the Owner or Owner’s representative. Drawings shall show actual installation details including all piping and equipment locations, room or facilities modifications, etc. One (1) copy of drawings shall be on reproducible type media.

4. All acceptance testing and final inspection documents shall be kept on site for a minimum of three years following final approval.

5. Submit two copies of guarantee per Division 1

B. Clean Up

1. Equipment, appurtenances, fixtures and exposed piping shall be clean, and all excess dope and oil shall be removed. Sprinkler heads shall be cleaned without the use of any solvents.

2. Upon completion of work, remove all surplus material, debris, and equipment associated with or used in the execution of this work. Sweep work and storage areas, as required, to remove metal shavings and oily residue.

END OF SECTION

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 104 deg F and at altitude of 3300 feet above sea level.

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 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 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

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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.

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:

1. Manufacturers:

   a. Metraflex Co.
   b. Flex-Hose Co. Inc.
   c. Or Approved Equal.

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 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 and 340 psig at 450 deg F ratings.

6. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.

   a. Stainless steel hoses and double-braid, stainless steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.

7. Expansion Joints for Steel Piping NPS 2 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 and 325 psig at 600 deg F ratings.

8. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon steel fittings with flanged end connections.
   a. Stainless steel hoses and double-braid, stainless steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.

2.3 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Manufacturers:

    a. Metraflex Co.
    b. Flex-Hose Co. Inc.
    c. Or Approved Equal.

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, stainless steel.
    b. Expansion Plug: Stainless steel.
    c. Washer and Nut: Stainless steel.

5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
    b. Stud: ASTM A307, stainless steel with continuous thread on stud unless otherwise indicated.
    c. Washer and Nut: Stainless 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 PACKLESS EXPANSION JOINTS

A. Install metal-bellows expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

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 on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

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.

C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least four 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 SUMMARY

A. Section Includes:

1. Sleeves without waterstop.
2. Sleeves with waterstop.
3. Sleeve-seal systems.
4. Grout.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES WITHOUT WATERSTOP

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends.

B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.

C. Steel Sheet Sleeves: ASTM A653/A653M, 0.0239-inch minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

D. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 SLEEVES WITH WATERSTOP

A. Manufacturers:

1. Metraflex Co.
2. Garlock.
3. Or Approved Equal.

B. Description: Manufactured galvanized steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers:

1. Garlock, LINK-SEAL.
2. Or Approved Equal.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Designed to form a hydrostatic seal of 20 psig minimum.
2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 coating of length required to secure pressure plates to sealing elements.

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, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

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 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. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, 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 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 078413 "Penetration Firestopping."

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs 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. Using grout, seal the space around outside of sleeves.

3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

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.

3.4 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.
2. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

3.5 SLEEVE SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

    a. Sleeves with waterstops.

        1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

    a. Sleeves with waterstops.

        1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

    a. Sleeves with waterstops.

4. Interior Partitions:

    a. Sleeves without waterstops.

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 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. McGuire Manufacturing Co.
2. Or Approved Equal.

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 steel with polished, chrome-plated finish 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 with polished, chrome-plated finish.
c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece steel 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 19

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Pressure gages.
5. Gage attachments.
6. Test plugs.
7. Test-plug kits.
8. Sight flow indicators.

B. Related Requirements:

1. Section 221119 "Domestic Water Piping Specialties" for water meters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers:

1. Weiss Instruments
2. Trerice
3. Or Approved Equal.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers:

   a. Weiss Instruments.
   b. Trerice.
   c. Or Approved Equal.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 7-inch 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.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, 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.

2.3 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.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.

9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers:

   a. Weiss Instruments.
   b. Trerice.
   c. Or Approved Equal.

2. Standard: ASME B40.1.
3. Case: Liquid-filled type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and [**piston**] [**porous-metal**]-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.6 TEST PLUGS

A. Manufacturers:

1. Weiss Instruments.
2. Trerice.
3. Or Approved Equal.

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 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: EPDM self-sealing rubber.

2.7 TEST-PLUG KITS

1. Manufacturers:

a. Weiss Instruments.
b. Trerice.
c. Or Approved Equal.

B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, 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. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.

E. Carrying Case: Metal or plastic, with formed instrument padding.

2.8 SIGHT FLOW INDICATORS

A. Description: Piping inline-installation device for visual verification of flow.

B. Construction: Bronze or stainless steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

C. Minimum Pressure Rating: 150 psig.

D. Minimum Temperature Rating: 200 deg F.

E. End Connections for NPS 2 and Smaller: Threaded.

F. End Connections for NPS 2-1/2 and Larger: Flanged.

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 direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.

J. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

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 shall be the following:

1. Liquid-filled, bimetallic-actuated type.
2. Test plug with EPDM self-sealing rubber inserts.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping:

1. 0 to 100 deg F.

B. Scale Range for Domestic Hot-Water Piping:

1. 0 to 250 deg F.

C. Scale Range for Domestic Cooled-Water Piping:

1. 0 to 100 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages shall be the following:

1. Liquid-filled, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping:

1. 0 to 160 psi.

B. Scale Range for Domestic Water Piping:

1. 0 to 160 psi.

END OF SECTION 22 05 19

SECTION 220523.12

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.

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 B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
4. 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. Hand Lever: For quarter-turn valves smaller than NPS 4.

G. Valves in Insulated Piping:

1. Provide 2-inch extended neck stems.
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 Stainless Steel Trim, Threaded or Soldered Ends:

1. Manufacturers:

a. Nibco No. T-585-66-LF or S-585-66-LF.
b. Apollo No. 77CLF-140-01A or 77CLF-240-01A.
c. Jomar No. T-200CSS or S-200CSS.
d. Or Approved Equal.

2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered.

7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

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. 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 220553 "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.

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 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Steel Piping, NPS 3 and Smaller: Threaded ends.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Provide with threaded or solder-joint ends.
2. Bronze ball valves, two piece with full port, and stainless steel trim. Provide with threaded or solder-joint ends.

3.6 CONDENSATE DRAIN VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Provide with threaded or solder-joint ends.
2. Bronze ball valves, two piece with full port, and stainless steel trim. Provide with threaded or solder-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. Ductile-Iron, single-flange (lug-type) butterfly valves.
2. Ductile-Iron, flangeless (wafer-type) butterfly valves.
3. Chainwheels.

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.

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 B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. 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. Gear Actuator: For valves NPS 8 and larger.
2. Hand lever: For valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to gear, handlever, or stem; of size and with chain for mounting height, according to "Installation of Valves" Article.

G. Valves in Insulated Piping: Provide 2-inch extended neck stems.

2.3 DUCTILE-IRON, SINGLE-FLANGE (LUG-TYPE) BUTTERFLY VALVES

A. Ductile Iron, Single-Flange (Lug-Type) Butterfly Valves with Aluminum-Bronze Disc:

1. Manufacturers:

a. Nibco No. LD-2000.
b. Apollo No. LD-145-XBE11.
c. Or Approved Equal.

2. Standard: MSS SP-67, Type I.
3. CWP Rating: 200 psig.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

5. Body Material: ASTM A536, ductile iron.
6. Seat: EPDM.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

2.4 DUCTILE-IRON, FLANGELESS (WAFER-TYPE) BUTTERFLY VALVES

A. Ductile Iron, Flangeless (Wafer-Type) Butterfly Valves with Aluminum-Bronze Disc:

1. Manufacturers:

a. Nibco No. WD-2000.
b. Apollo No. WD-145-XBE11.
c. Or Approved Equal.

2. Standard: MSS SP-67, Type I.
3. CWP Rating: 200 psig.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A536, ductile iron.
6. Seat: EPDM.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

2.5 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to handwheels.

1. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve. Include zinc or epoxy coating.
2. Chain: Stainless steel, of size required to fit sprocket rim.

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.

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. Install chainwheels on actuators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

G. Valve Tags: Comply with requirements in Section 220553 "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 and Larger:

1. Ductile-Iron, Single-Flange (Lug-Type) Butterfly Valves: 200 CWP, EPDM seat, and aluminum-bronze disc. Provide with Single-Flange (Lug-Type) or Flangeless (Wafer-Type) ends.

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, lift check valves.
2. Bronze, swing check valves.
3. Iron, swing check valves.
4. Iron, center-guided check valves.
5. Iron, door-type check valves.

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, 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.

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 B16.22 for wrought copper solder joint.
6. 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, IN-LINE CHECK VALVES

A. Bronze, In-Line Check Valves with Nonmetallic Disc, Class 125:

1. Manufacturers:

a. Nibco No. T-480-Y-LF or S-480-Y-LF.
b. Apollo No. 61LF-500 or 61LF-600.
c. Or Approved Equal.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.

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 Nonmetallic Disc, Class 125:

1. Manufacturers:

a. Nibco No. T-413-Y-LF or S-413-Y-LF.
b. Or Approved Equal.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: PTFE.

2.5 IRON, SWING CHECK VALVES

A. Iron, Swing Check Valves with Rubber Flapper, Class 125:

1. Manufacturers:

a. Cla Val No. 584.
b. Apco No. 100
c. Or Approved Equal.

2. Description:

a. Standard: AWWA C508.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A536, ductile iron.
d. Ends: Flange.
e. Flapper: NBR.

2.6 IRON, CENTER-GUIDED, SPRING-LOADED CHECK VALVES

A. Iron, Globe, Center-Guided Check Valves with Metal Seat, Class 150:

1. Manufacturers:

a. Cla-Val No. 581
b. Apco No. CSC-640
c. Or Approved Equal.

2. Description:

a. Standard: MSS SP-125.
b. CWP Rating: 250 psig.
c. Body Material: ASTM A536, ductile iron.
d. Style: Globe, spring loaded.
e. Ends: Flange.
f. Seat: 304 Stainless Steel.

2.7 IRON, DOOR-TYPE CHECK VALVES

A. Iron, Wafer, Two-Door Check Valves with Resilient Seat, Class 150:

1. Manufacturers:

a. Cla Val No. 582
b. Apco No. CDD-9000T
c. Or Approved Equal.

2. Standard: API 594.
3. CWP Rating: 200 psig.
4. Body Design: Wafer, spring-loaded doors.
5. Body Material: ASTM A536, ductile iron.
6. Door Material: ASTM B148, aluminum bronze.
7. Seat: EPDM or NBR.

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.

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.
2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

I. Install valve tags. Comply with requirements in Section 220553 "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 valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze, swing check valves with nonmetallic disc.
b. NPS 2-1/2 and Larger for Domestic Water: Iron, two-door, resilient seat check valves.
c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron, swing check valves with rubber flapper.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded, or soldered connections.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flange or threaded.
3. For Copper Tubing, NPS 5 and Larger: Flange.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze, swing check valves with nonmetallic disc, Class 125, with soldered or threaded end connections.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, center-guided check valves with globe, metal seat, Class 150, with flange end connections.
2. Iron, two-door check valves with resilient seat, Class 150, with wafer connections.

3.6 CONDENSATE DRAIN VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze, swing check valves with nonmetallic disc, Class 125, with soldered or threaded end connections.

3.7 SANITARY WASTE AND STORM DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Iron, swing check valves with rubber flapper.

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. Trapeze pipe hangers.
3. Metal framing systems.
4. Fiberglass strut systems.
5. Thermal hanger-shield inserts.
6. Fastener systems.
7. Pipe stands.
8. Pipe-positioning systems.
9. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
3. Section 220548 "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.

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.
3. Fiberglass strut systems.
4. Pipe stands.
5. 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 014000 "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:

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 stainless 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 stainless steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers:

   a. Cooper B-Line.
   b. Unistrut Corp.
   c. Or Approved Equal.

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: 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: Hot-dip galvanized.
9. Paint Coating: Green epoxy, acrylic, or urethane.

2.5 THERMAL HANGER-SHIELD INSERTS

A. Manufacturers:

1. National Pipe Hanger Corp.
2. ASC Engineering Solutions.
3. Insulation Components.
4. Or Approved Equal.

B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psig 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 beyond sheet metal shield for piping operating below ambient air temperature.

2.6 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.

1. Manufacturers:

a. Hilti.
b. Simpson.
c. Or Approved Equal.

B. 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:

a. Hilti.
b. Simpson.
c. Or Approved Equal.

2. Indoor Applications: Stainless steel.
3. Outdoor Applications: Stainless steel.

2.7 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:

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 rods.
4. Horizontal Member: Adjustable horizontal, stainless-steel pipe support channels.
5. Pipe Supports: Strut clamps.
6. Hardware: Stainless steel.
7. Accessories: Protection pads.

8. Height: 12 inches above roof.

D. High-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Single vulcanized rubber or molded polypropylene.

3. Vertical Members: Two stainless-steel, continuous-thread, 1/2-inch rods.
4. Horizontal Member: One adjustable-height, stainless-steel, pipe-support slotted channel or plate.
5. Pipe Supports: Clevis hanger.
6. Hardware: Stainless steel.
7. Accessories: Protection pads, 1/2-inch continuous-thread, stainless-steel rod.
8. Height: 36 inches above roof.

E. High-Profile, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: Two or more; molded polypropylene.

3. Vertical Members: Two or more, stainless-steel channels.
4. Horizontal Members: One or more, adjustable-height, stainless-steel pipe support.
5. Pipe Supports: Clevis hanger.
6. Hardware: Stainless steel.
7. Accessories: Protection pads, 1/2-inch, continuous-thread rod.
8. Height: 36 inches.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.8 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.

2.9 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.10 MATERIALS

A. Aluminum: ASTM B221.

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, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "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.

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 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:

1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

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 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 Above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
   c. 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 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 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

b. NPS 4: 12 inches long and 0.06 inch thick.
c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 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 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 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.

3.6 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.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 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.

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, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for outdoor, and hostile environment applications.

G. Use copper-plated pipe hangers and 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.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, 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.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
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, 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, 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 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, 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, 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 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 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 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.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 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 for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F 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.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F 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-joist 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.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

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:

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.
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 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 53

IDENTIFICATION FOR PLUMBING 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. Valve tags.
6. Warning 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. Metal Labels for Equipment:

1. Manufacturers:

a. Seton.
b. Brady.
c. Or Approved Equal.

2. Material and Thickness: Stainless steel, 0.025-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. 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:

1. Seton.
2. Brady.
3. Or Approved Equal.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch 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.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, 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. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 WARNING TAPE

A. Manufacturers:

1. Seton.
2. Brady.
3. Or Approved Equal.

B. Material: Vinyl.

C. Minimum Thickness: 0.005 inch.

D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

F. Maximum Temperature: 160 deg F.

G. Minimum Width: 2 inches.

2.4 PIPE LABELS

A. Manufacturers:

1. Seton.
2. Brady.
3. Or Approved Equal.

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.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. 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 main 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.

2.5 VALVE TAGS

A. Manufacturers:

1. Seton.
2. Brady.
3. Or Approved Equal.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: stainless steel, 0.024-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire or 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 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.

2.6 WARNING TAGS

A. Manufacturers:

1. Seton.
2. Brady.
3. Or Approved Equal.

B. Description: Preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

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.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where are-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.4 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. 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. 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. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

E. 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.

F. 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 Vent Piping: White letters on a black background.
5. Storm Drainage Piping: White letters on a black background.
6. Condensate Drainage Piping: White letters on a black background.
7. Nonpotable Cold Water Piping: Black letters on an ANSI Z535.1 safety-yellow background.

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, 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, round.
b. Domestic Hot Water: 1-1/2 inches, round.
c. Domestic Hot-Water Return: 1-1/2 inches, round.
d. Nonpotable Cold Water: 1-1/2 inches, 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.

3.7 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.

B. Attach warning tags, with proper message, to equipment and other items where scheduled.

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 sanitary sewage system.
3. TAB of rainwater system.
4. TAB of condensate drainage system.
5. TAB of plumbing equipment:

   a. Domestic water booster pumps.
   b. Domestic hot-water in-line circulation pumps.

6. Pipe-leakage test 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.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 60 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 60 days of Contractor's Notice to Proceed, submit the Contract Documents Review review report, as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 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 60 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.

1.5 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. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."

D. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

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.

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:

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. Pressure reducing valves are installed and functioning.
e. Water treatment is complete.
f. Systems are flushed, filled, and air purged.
g. Strainers are clean.
h. Control valves are functioning in accordance with the sequence of operation.
i. Shutoff and balance valves are 100 percent open.
j. Hot-water circulating pumps are operational and proper rotation is verified.
k. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
l. Variable-frequency controllers' startup is complete and safeties are verified.
m. Suitable access to balancing devices and equipment is provided.

2. Sanitary Sewage/Drainage System:

a. Leakage and pressure tests on sanitary sewage/drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
b. Piping is complete.
c. Suitable access to equipment is provided.

3. Rainwater Drainage System:

a. Leakage and pressure tests on rainwater drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
b. Piping is complete.
c. Suitable access to equipment is provided.

4. Condensate Drainage System:

a. Leakage and pressure tests on condensate drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
b. Piping is complete.
c. Condensate drainage pumps are operational.
d. Shutoff valves are 100 percent open.
e. Suitable access to 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 220716 "Plumbing Equipment Insulation" and Section 220719 "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. Motors.
2. Domestic water in-line pumps.
3. Domestic water heaters.

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 and thermostatic mixing valve 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. Verify that motor controllers are equipped with properly sized thermal protection.
7. 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, self-contained control valves, and pressure-reducing 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.
3. Re-measure each main and branch after all have been adjusted.

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.

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 MOTORS

A. Motors 1/2 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.

3.8 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. Measure and Record relief valve(s) pressure setting.
5. Capacity: Calculate in Btu/h of heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

3.9 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, within 10 percent.

3.10 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.

3.11 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:

    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.
        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.
        b. Entering-water temperature in deg F.
        c. Leaving-water temperature in deg F.
        d. High-temperature-limit setting in deg F.
        e. Operating set point in deg F.
        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.
        g. Water-pressure differential in feet of head or psig.
        h. Required net positive suction head in feet of head or psig.
        i. Pump speed.
        j. Impeller diameter in inches.
        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.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
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.

3.12 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 20 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.

2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.13 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 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic hot-water piping.
2. Domestic recirculating hot-water piping.
3. Domestic chilled-water piping for drinking fountains.
4. Condensate drain water piping.
5. Supplies and drains for handicap-accessible lavatories and sinks.

B. Related Sections:

1. Section 220716 "Plumbing Equipment Insulation" for equipment insulation.

1.2 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. 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 pipe expansion joints for each type of insulation.
3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4. Detail removable insulation at piping specialties, equipment connections, and access panels.
5. Detail application of field-applied jackets.
6. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size, as well as ASTM standard designation and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "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.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. 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, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 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 are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel 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 are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I for tubular materials.

1. Manufacturers:

a. Aeroflex USA Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. Or Approved Equal.

G. Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.

1. Manufacturers:

a. Johns Manville; Micro-Lok HP.
b. Owens Corning; Fiberglas Pipe Insulation.
c. Knauf Insulation; 1000 Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Or Approved Equal.

2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ-SSL.
3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.3 INSULATING CEMENTS

A. Glass-Fiber Insulating Cement: Comply with ASTM C195.

1. Manufacturers:

a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
c. Or Approved Equal.

B. Glass-Fiber Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

1. Manufacturers:

a. Insulco, Division of MFS, Inc.; SmoothKote.
b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
c. Rock Wool Manufacturing Company; Delta One Shot.
d. Or Approved Equal.

2.4 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. Manufacturers:

    a. Owens Corning; FOAMGLAS PC 62 Adhesive.
    b. Or Approved Equal.

C. Flexible Elastomeric Adhesive: Solvent-based adhesive. Comply with MIL-A-24179A, Type II, Class I.

1. Manufacturers:

    a. Aeroflex USA Inc.; Aeroseal.
    b. Armacell LCC; 520 Adhesive.
    c. Foster Products Corporation, H. B. Fuller Company; 85-75.
    d. RBX Corporation; Rubatex Contact Adhesive.
    e. Or Approved Equal.

2. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
3. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when
4. calculated according to 40 CFR 59, Subpart D (EPA Method 24)
5. Wet Flash Point: Below 0 deg F.
6. Service Temperature Range: 40 to 200 deg F.
7. Color: Black.

D. Glass-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers:

    a. Childers Products, Division of ITW; CP-82.
    b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    d. Marathon Industries, Inc.; 225.
    e. Mon-Eco Industries, Inc.; 22-25.
    f. Or Approved Equal.

E. 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:

    a. Childers Products, Division of ITW; CP-82.
    b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    d. Marathon Industries, Inc.; 225.
    e. Mon-Eco Industries, Inc.; 22-25.
    f. Or Approved Equal.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers:

    a. Dow Chemical Company (The); 739, Dow Silicone.

b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Speedline Vinyl Adhesive.
e. Or Approved Equal.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

1. Manufacturers:

a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. ITW TACC, Division of Illinois Tool Works; CB-50.
d. Marathon Industries, Inc.; 590.
e. Mon-Eco Industries, Inc.; 55-40.
f. Vimasco Corporation; 749.
g. Or Approved Equal.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
5. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.

1. Manufacturers:

a. Childers Products, Division of ITW; CP-30.
b. Foster Products Corporation, H. B. Fuller Company; 30-35.
c. ITW TACC, Division of Illinois Tool Works; CB-25.
d. Marathon Industries, Inc.; 501.
e. Mon-Eco Industries, Inc.; 55-10.
f. Or Approved Equal.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to 180 deg F.
4. Color: White.

D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

1. Manufacturers:

a. Childers Products, Division of ITW; Encacel.
b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
c. Marathon Industries, Inc.; 570.

d. Mon-Eco Industries, Inc.; 55-70.
e. Or Approved Equal.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Manufacturers:

a. Childers Products, Division of ITW; CP-10.
b. Foster Products Corporation, H. B. Fuller Company; 35-00.
c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
d. Marathon Industries, Inc.; 550.
e. Mon-Eco Industries, Inc.; 55-50.
f. Vimasco Corporation; WC-1/WC-5.
g. Or Approved Equal.

2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.6 LAGGING ADHESIVES

A. Adhesives comply with MIL-A-3316C, Class I, Grade A, and are compatible with insulation materials, jackets, and substrates.

1. Manufacturers:

a. Childers Products, Division of ITW; CP-52.
b. Foster Products Corporation, H. B. Fuller Company; 81-42.
c. Marathon Industries, Inc.; 130.
d. Mon-Eco Industries, Inc.; 11-30.
e. Vimasco Corporation; 136.
f. Or Approved Equal.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 20 to plus 180 deg F.
4. Color: White.

2.7 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Manufacturers:

a. Childers Products, Division of ITW; CP-70.

b. Or Approved Equal.

2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 58 to plus 176 deg F .
4. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers:

a. Childers Products, Division of ITW; CP-76-8.
b. Foster Products Corporation, H. B. Fuller Company; 95-44.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.
f. Or Approved Equal.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Manufacturers:

a. Childers Products, Division of ITW; CP-76.
b. Or Approved Equal.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.8 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. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136 Types I, II, III, IV, and VII.
5. PSK Jacket: Aluminum foil fiberglass reinforced scrim with polyethylene backing, complying with ASTM C1136, Type II.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, 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:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto PVC Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.
e. Or Approved Equal.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
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.

D. Metal Jacket:

1. Manufacturers:

a. Childers Products, Division of ITW; Metal Jacketing Systems.
b. PABCO Metals Corporation; Surefit.
c. RPR Products, Inc.; Insul-Mate.
d. Or Approved Equal.

2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil-thick polysurlyn.
d. Moisture Barrier for Outdoor Applications: 3-mil-thick polysurlyn.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless Steel Jacket: ASTM A240/A240M.

a. Factory cut and rolled to size.
b. Material, finish, and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 3-mil-thick polysurlyn.
d. Moisture Barrier for Outdoor Applications: 2.5-mil-thick polysurlyn.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane, consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Manufacturers:

a. Pittsburgh Corning Corporation; Pittwrap.
b. Polyguard; Insulrap No Torch 125.
c. Or Approved Equal.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
b. Compac Corp.; 104 and 105.
c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
e. Or Approved Equal.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Manufacturers:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
b. Compac Corp.; 110 and 111.
c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

e. Or Approved Equal.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. 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:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
b. Compac Corp.; 130.
c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
d. Venture Tape; 1506 CW NS.
e. Or Approved Equal.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
d. Venture Tape; 3520 CW.
e. Or Approved Equal.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

1. Manufacturers:

a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.
d. Or Approved Equal.

2. Stainless Steel: ASTM A240/A240M, Type 316; 0.015 inch thick, 3/4 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers:

a. C & F Wire.
b. Childers Products.
c. PABCO Metals Corporation.
d. RPR Products, Inc.
e. Or Approved Equal.

2.12 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers:

a. McGuire Manufacturing Co., Inc.; ProWrap
b. Or Approved Equal.

2. Description: ADA Seamless Insulator Covers and PreWrapped P-Traps. All exposed lavatory and sink trim on wheelchair-accessible fixtures shall be covered with the seamless antimicrobial vinyl insulating outer shell. Insulating kits shall include a cover for the drain tailpiece, all p-trap brass components, and covers for hot and cold supplies. Comply with Americans with Disabilities Act (ADA) requirements.
3. Material: Flame retardant, fungal, and bacterial resistant, molded closed cell vinyl.
4. Fasteners: None.

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 prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300

deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

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, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

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 during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.

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, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. 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 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.

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 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 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 below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. 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.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. 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 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. 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 078413 "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 below.

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 made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill 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 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 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 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. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric, 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 conforms 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.
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 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 sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
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 prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated 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.

3.7 INSTALLATION OF GLASS-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 jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with 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 prefabricated 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 glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated 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 prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated 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 INSTALLATION OF FIELD-APPLIED JACKETS

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 overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-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 laps at longitudinal seams and 3-inch-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 overlap at longitudinal seams and end joints. 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 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 o.c. and at end joints.

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 099113 "Exterior Painting" and Section 099123 "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. Engage a qualified testing agency to perform tests and inspections.

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 is 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.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. 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 1-1/2 and Smaller: Insulation is the following:

   a. Glass-Fiber, Preformed Pipe Insulation, Type I: Minimum thickness not less than the diameter of the pipe.

2. NPS 2 and Larger: Insulation is the following:

   a. Glass-Fiber, Preformed Pipe Insulation, Type I: 2 inch thick.

B. Condensate Drain Water:

1. NPS 1 and Smaller: Insulation is the following:

   a. Flexible Elastomeric: 1/2 inch thick.

2. NPS 1-1/4 and Larger: Insulation is the following:

a. Flexible Elastomeric: 1 inch thick.

C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation is the following:

a. McGuire ProWrap Seamless Insulator Covers.

D. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation is the following:

a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

3.13 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. Piping, Concealed:

1. None.

C. Piping, Exposed:

1. PVC: 30 mils thick.

3.14 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. Piping, Concealed:

1. Stainless Steel, Type 316, Stucco Embossed: 0.024 inch thick.

C. Piping, Exposed:

1. Stainless Steel, Type 316, Stucco Embossed with Z-Shaped Locking Seam: 0.024 inch thick.

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SECTION 22 08 00

COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements that apply to implementation of commissioning of plumbing systems, assemblies and components.

B. Related Documents:

1. Drawings and general provisions of the subcontract apply to this section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

C. Related Sections:

1. Division 01 Section "General Requirements."
2. Division 01 Section "Special Procedures."
3. Division 22 Plumbing Sections.

1.2 REFERENCES

A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the work.
3. Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.

1.3 DESCRIPTION

A. The purpose of commission is to ensure the owner that work has been completed as specified and that systems are functioning in the manner as described in division 220000 and specified system operating criteria. It will assist operating staff training and familiarization with new systems. It will serve as a tool to reduce post-occupancy critical systems operational difficulty or failure. It will, also, be used to develop test protocol and record the associated test data in an effort to advance the building systems from a state of substantial completion to a full dynamic operation.

B. Commission will commence after preliminary punch list items are completed by subcontractors.

C. The steps associated with commissioning are outlined below:

1. Step One - Installation Verification
2. Step Two - System Start-Up.
3. Step Three – Functional Performance Testing.

D. Operational staff training is essential to the commission process and will run concurrently with steps one through three.

E. The commissioning team will include representatives of the owner, construction and installing subcontractors, test and balance subcontractor, and construction subcontractor's commissioning agent. Equipment manufacturer's representatives will be present for start-up as specified in the equipment specification sections and for equipment training.

1.4 PLUMBING SYSTEMS TO BE COMMISSIONED

A. Commissioning will be performed on the following systems:

1. Domestic Heating Hot Water System.

1.5 SUBMITTALS

A. Submit under provisions of Division 22 and Division 01 Section "General Requirements."

B. Commissioning plan as prepared by the prime subcontractor or his commissioning agent.

C. Prime subcontractors or his Commissioning Agent shall provide Functional Performance Tests (FPT) procedures for the above listed systems. Prime subcontractors or his commissioning agent shall provide system narrative descriptions as part of the FPT procedures.

PART 2 - PRODUCTS

2.1 COMMISSIONING PLAN

A. The commissioning plan shall outline the organization, scheduling, team members, and documentation pertaining to the overall commissioning process.

2.2 NARRATIVE DESCRIPTIONS

A. A narrative description of the design intents of the systems and their intended modes of sequences of operation.

2.3 FUNCTIONAL PERFORMANCE TESTS (FPT) PROCEDURES

A. The FPT procedures at the minimum shall consist of the following sections:

1. Narrative Description:

a. This section provides a narrative description of the design intents of the systems and their intended modes of sequences of operation.

2. Testing Prerequisites:

   a. This section contains verification that primary mechanical, electrical, and controls systems that support or interact with the system that the FPT is prepared against are completed, tested and operational.

3. Installation Verification:

   a. This section contains verification that the system installation is completed and is ready for commissioning.

4. Commencement of Functional Performance Testing:

   a. This section records the date and time of the start of system commissioning.

5. System Condition Prior to Staring Performance Testing:

   a. This section records the current set points and parameters of the system at the start of commissioning.

6. Functional Performance Test:

   a. This section shall provide the following:

      1) Sequential steps required to set parameters and conditions required to test component and functions throughout intended ranges of operation.
      2) Full range of checks and tests carried out to determine if electric and pneumatic connections, components, subsystems, systems and interfaces between systems function in accordance with the contract documents and design intents.
      3) All modes and sequences of control operations, interlocks and conditional control responses and specified responses to abnormal emergency conditions.

7. End of Functional Performance Test:

   a. This section records the date and time of the end of system commissioning.

8. Field Notes:

   a. This section records notes or remarks during system commissioning.

9. List systems modifications, not required by the Contract Documents, but provided by the Subcontractor. List other questions regarding such system modifications.
10. List problems discovered during commissioning that were corrected.
11. List problems discovered during commissioning that were not corrected.
12. List recommended party that should take action on these problems.

PART 3 - EXECUTION

3.1 GENERAL

A. The Subcontractors shall be responsible for performing procedures presented in specification and contract drawings as detailed in the Functional Performance Tests (FPT). Members of the designated commissioning team shall witness various portions of the commissioning process. Responsibilities for these activities are listed in the following paragraphs. Commissioning team members shall sign-off on appropriate sections after verifying installation, operation, or documentation. Final sign-off shall be by the owner and commissioning agent.

B. Any test ports, gauges, test equipment, etc., needed to accomplish the functional performance tests shall be provided by Subcontractors.

C. Subcontractors shall provide to the commissioning team documentation of calibration of controls. Documentation shall include dates, setpoints, calibration coefficients, control loop verification, and other data required to verify system check-out. Documentation shall be dated and initialed by field engineer or technician performing the work.

3.2 OPERATIONAL STAFF TRAINING

A. System narrative descriptions will be prepared by the commission agent and supported by flow diagrams, one line diagrams, and appropriate specification sections for major systems to be commissioned. The commission agent will coordinate “system description” meetings with members of facility management and maintenance department groups to review system description documentation. The meetings will provide an overview of major system features, components, and arrangements.

B. The subcontractor and associated manufacturer’s representatives shall provide required training to operational staff after the system description meetings have occurred. The subcontractor training sessions shall provide a more detailed analogy of systems operation and maintenance.

3.3 INSTRUMENTATION

A. Instrumentation will be provided by the subcontractor. Instruments used for measurements shall be accurate. Calibration histories for each instrument shall be available for examination. Calibration and maintenance of instruments shall be in accordance with the requirements of NEBB or AABC standards.

B. Application of instruments and accuracy of measurements shall be in accordance with NEBB or AABC standards.

3.4 DOCUMENTATION

A. The installing subcontractor shall be responsible for collection of pertinent data during system start-up and functional performance testing. The subcontractor shall submit to the commissioning agent documentation of tests performed prior to and after system start-up. Documentation shall also include start-up procedures as approved by commissioning team.

B. Documentation is to be typewritten on 8-1/2 by 11 inches paper and inserted in a 2 inches to 3 inches thick three ring binder. Indicate the project name, number, volume number, and volume title on the end panel of each binder.

C. Provide a title sheet for each volume and list the following:

1. Volume title and section name and number requiring this submittal.

2. Project name, project number, and address.
3. Subcontractor name, address, and phone number.
4. Name, title, signature, and date of person making the submittal.
5. Name of owner, a blank line for signature, and the date of person accepting the submittal.
6. Name, address, and phone number of commission agent; a blank line for signature; and date of person accepting the submittal.

D. Provide a table of contents for multiple submittals. List each submittal and page number. Number each page, centered on the bottom in sequential numerical order. Provide tabs for multiple submittals in a single binder.

3.5 STEP ONE - INSTALLATION VERIFICATION

A. General Commissioning Responsibilities:

1. Before system start-up begins, the commission team shall conduct a final installation verification audit. The subcontractor shall be responsible for completion of work including change orders and punch list items to the owners satisfaction. The audit shall include, but not be limited to, checking of:

   a. Piping specialties including balance, control, and isolation valves.
   b. Identification of piping, valves, equipment, controls, etc.
   c. Major equipment, pumps, valves, starters, gauges, thermometers, etc.
   d. Documentation of prestart-up tests performed, including manufacturer's factory tests.

2. If work is found to be incomplete, incorrect, or non-functional, the subcontractor shall correct the deficiency before system start-up work proceeds.

3.6 STEP TWO - SYSTEM START-UP

A. General Commissioning Responsibilities:

1. A start-up plan shall be developed and submitted by the installing subcontractor. Start-up plan to include the following:

   a. Flushing and cleaning of pipe.
   b. Filters, strainers, and screens.
   c. Electrical tests.
   d. Pressure tests.
   e. Safeties.
   f. Chemical treatment.
   g. Manufacturer's tests.

2. The start-up plan will be reviewed, and a prestart-up inspection performed by designated members of the commissioning team. The installing subcontractor shall commence with system start-up after approval has been given to start-up plan and the prestart-up inspection is completed. Designated members of the commissioning team shall witness system start-up and list system, and equipment deficiencies noted during start-up. The subcontractor shall take corrective action on system deficiencies noted and demonstrate to the commissioning team members suitable system operation.

3. Designated systems requiring test and balance work shall have this activity commence after systems have successfully completed start-up. System and equipment deficiencies observed during this activity is to be noted and corrected.

3.7 STEP THREE - FUNCTIONAL PERFORMANCE TESTING

A. General Commissioning Responsibilities:

1. Functional performance testing begins after operational testing, adjusting, and balancing of the systems have been completed by the subcontractors; and the system description and hands-on training sessions have been completed.
2. The objective of the functional performance testing is to advance the building systems from a state of substantial completion to full dynamic operation in accordance with the specified design requirements and design intent.
3. Attaining this object will be accomplished by developing individual systems testing protocols which, when implemented by the subcontractor, will allow the commissioning team to observe, evaluate, identify deficiencies, recommend modifications, tune, and document the systems and systems equipment performance over a range of load and functional levels.
4. Functional performance tests for the systems to be commissioned are defined in the commissioning plan. These tests are intended to be conclusive but may require minor modifications as system operation dictates.

END OF SECTION 22 80 00

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Piping joining materials.
3. Encasement for piping.
4. Transition fittings.
5. Dielectric fittings.

B. Related Requirements:

1. Section 331415 "Site Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.

1.3 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.

1.4 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 only after arranging to provide temporary water service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Construction Manager'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 K and ASTM B88, Type L.

B. Annealed-Temper Copper Tube: ASTM B88, Type K.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Wrought Copper Unions: ASME B16.22.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch 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: 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:

a. Cascade Waterworks Manufacturing.
b. Dresser, Inc.; Dresser Piping Specialties.
c. Ford Meter Box Company, Inc. (The).
d. JCM Industries.
e. Romac Industries, Inc.
f. Smith-Blair, Inc; a Sensus company.
g. Viking Johnson; c/o Mueller Co.
h. Or Approved Equal.

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:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Hart Industries International, Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Wilkins Water Control Products.
g. Or Approved Equal.

2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig minimum at 180 deg F.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers:

a. Watts; a division of Watts Water Technologies, Inc.
b. Capitol Manufacturing Company.
c. Central Plastics Company.
d. Matco-Norca.
e. Wilkins.
f. Zurn Industries, LLC.
g. Or Approved Equal.

2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180 deg F.
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:

a. Advance Products & Systems.
b. Calpico, Inc.
c. Drake Specialties.
d. M&P Flange & Pipe Protection.
e. Or Approved Equal.

2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers:

a. Perfection Corporation; a subsidiary of American Meter Company.
b. Precision Plumbing Products, Inc.
c. Matco-Norca.
d. Victaulic Company.
e. Or Approved Equal.

2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
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. Under-building-slab, domestic water, building-service piping, shall be the following:

1. Annealed-temper copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

D. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:

1. Drawn-temper or annealed-temper copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

E. Aboveground domestic water piping shall be the following:

1. Drawn-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and soldered joints.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "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 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
3. Section 220523.14 "Check Valves for Plumbing Piping."
4. Section 220523.15 "Gate Valves for Plumbing Piping."

E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

F. Install domestic water piping level and plumb.

G. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "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 pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220519 "Meters and Gages for Plumbing Piping."

Q. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."

R. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

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. 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.

G. 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 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

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 and Smaller: Use dielectric nipples or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

C. Install hangers for copper piping, 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 of each fitting.

E. Support vertical runs of copper piping to comply with MSS SP-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. Domestic Water Booster Pumps: Cold-water suction and discharge piping.

2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

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.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

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.
d. Cap and subject piping to static water pressure of 50 psig 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. Hydrostatic testing and documentation of test results for polypropylene piping to be in accordance with the manufacturer's instructions and submitted to the manufacturer upon successful completion per warranty requirements.
f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
g. 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 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 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. Clean non-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 procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 22 11 16

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.

B. Related Requirements:

1. Section 221123.13 "Domestic-Water Packaged Booster Pumps" for booster systems.

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.

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.
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."
2. Component Importance Factor: 1.0.

2.2 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

1. Manufacturers:

a. Grundfos, UP Series.
b. Taco, SmartPlus.
c. Or Approved Equal.

B. Capacities and Characteristics: See pump schedule on drawings.

C. 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.

3. Maximum Continuous Operating Temperature: 220 deg F.
4. Casing: Stainless steel, with companion-flange connections.
5. Impeller: Stainless steel.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "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.

2.4 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 65 to 200 deg F.
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 120 V ac.
7. Settings: Start pump at 115 deg F and stop pump at 125 deg F.

B. 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. 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. Pump Mounting:

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. 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 220548 "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 220529 "Hangers and Supports for Plumbing Piping and Equipment."

E. Install thermostats in hot-water return piping.

F. Install timers on wall.

G. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "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.

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 and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in the following:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.14 "Check Valves for Plumbing Piping."
3. Install pressure gauge and snubber at suction of each pump and pressure gauge and snubber at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220519 "Meters and Gages 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 220553 "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.

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 thermostats, and 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 SUMMARY

A. Section Includes:

1. Hubless, cast-iron soil pipe and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For drainage system. Include plans, elevations, sections, and details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. 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.

C. Field quality-control reports.

1.4 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10 ft. head of water.

B. Seismic Performance: Soil, waste, and vent piping and support and installation to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment":

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.

2.2 PIPING MATERIALS

A. Piping materials to 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:

1. Charlotte Pipe.
2. Tyler Pipe.
3. Or Approved Equal.

B. Pipe and Fittings:

1. Marked with CISPI collective trademark.
2. ASTM A888 or CISPI 301.

C. CISPI, Hubless-Piping Couplings:

1. Manufacturers:

a. Anaco-Husky.
b. Charlotte.
c. Mission.
d. Or Approved Equal.

2. Standards: ASTM C1277 and CISPI 310.
3. Clamps: Type 301 stainless steel. Two clamps for NPS 4 and smaller, four clamps for NPS 5 thru NPS 10, and six clamps for NPS 12 and larger.
4. Screws: Type 305 AISI or 304L stainless steel with 5/16-inch head for sizes NPS 10 and smaller, and 3/8-inch head for sizes NPS 12 thru NPS 15.
5. Shield: Type 301 stainless steel corrugated, 0.0075 thickness.
6. Gasket: ASTM C564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers:

a. Anaco-Husky; 4000 Series.
b. Or Approved Equal.

2. Standards: ASTM C1277 and ASTM C1540.
3. Clamps: Type 304 stainless steel. Four clamps for NPS 4 and smaller, and six clamps for NPS 5 and larger.
4. Screws: Type 305 AISI or 304L stainless steel with 3/8-inch head.
5. Shield: Type 304 AISI stainless steel corrugated, 0.015 thickness.
6. Gasket: ASTM C564, rubber sleeve with integral, center pipe stop.

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 of 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:

      1) Anaco-Husky; 4200 Series
      2) Or Approved Equal.

   b. Standard: ASTM C1460.
   c. Clamps: Type 304 AISI stainless steel. Four clamps for NPS 4 and smaller, and six clamps for NPS 6 and larger.
   d. Screws: Type 305 AISI or 304L stainless steel with 3/8-inch head.
   e. Shield: Type 304 AISI stainless steel corrugated, 0.015 thickness.
   f. Gasket: ASTM C564, rubber sleeve with integral, center pipe stop.
   g. End Connections: Same size as and compatible with pipes to be joined.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

   a. Manufacturers:

      1) Capitol Manufacturing Company.
      2) Central Plastics Company.
      3) EPCO Sales, Inc.
      4) Hart Industries International, Inc.
      5) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      6) Zurn Plumbing Products Group; Wilkins Water Control Products.
      7) Or Approved Equal.

   b. Standard: ASSE 1079.
   c. Pressure Rating: 125 psig minimum at 180 deg F.
   d. End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. Manufacturers:

1) Watts; a division of Watts Water Technologies, Inc.
2) Capitol Manufacturing Company.
3) Central Plastics Company.
4) Matco-Norca.
5) Wilkins.
6) Zurn Industries, LLC.
7) Or Approved Equal.

b. Standard: ASSE 1079.
c. Factory-fabricated, bolted, companion-flange assembly.
d. Pressure Rating: 125 psig minimum at 180 deg F.
e. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Manufacturers:

1) Advance Products & Systems.
2) Calpico, Inc.
3) Drake Specialties.
4) M&P Flange & Pipe Protection.
5) Or Approved Equal.

b. Nonconducting materials for field assembly of companion flanges.
c. Pressure Rating: 150 psig.
d. Gasket: Neoprene or phenolic.
e. Bolt Sleeves: Phenolic or polyethylene.
f. Washers: Phenolic with steel backing washers.

2.5 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch minimum thickness.

C. Form: Tube.

D. Color: Natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "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.

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 piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment".

K. 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.

L. 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.

M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Waste Piping: Two percent downward in direction of flow.
3. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping in accordance with 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 in accordance with ASTM A674 or AWWA C105/A 21.5.

O. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

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. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install drains in sanitary waste gravity-flow piping.

a. Comply with requirements for drains specified in Section 221319 "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 220517 "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 220517 "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 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for sanitary drainage piping joints to comply with the following conditions:

a. Provide axial restraint for pipe and fittings 5 inches 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 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
c. Provide rigid sway bracing for pipe and fittings 5 inches 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 Waste Drainage Piping: Shielded, nonpressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment".

1. Install stainless steel pipe hangers for horizontal piping.
2. Install stainless steel pipe support clamps for vertical piping.
3. Vertical Piping: MSS Type 8 or Type 42 clamps.
4. Install individual, straight, horizontal piping runs:

a. 100 Ft. and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Ft.: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Ft. if Indicated: MSS Type 49, spring cushion rolls.

5. Multiple, Straight, Horizontal Piping Runs 100 Ft. or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.

6. Base of Vertical Piping: MSS Type 52 spring hangers.

C. Install hangers for cast-iron soil piping, 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 and tubing within 12 inches of each fitting and coupling.

E. Support vertical runs of cast-iron soil piping to comply with MSS SP-58, 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.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "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 in accordance with 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 ft. head of water.
   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.

   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.
   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. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

A. Aboveground, soil and waste piping are to be the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

B. Aboveground, vent piping is to be the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

C. Underground, soil, waste, and vent piping are to be the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

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 076200 "Sheet Metal Flashing and Trim" for metal roof flashing assemblies.
2. Section 077200 "Roof Accessories" for preformed flashings.
3. Section 078413 "Penetration Firestopping" for through-penetration firestop assemblies.
4. Section 221423 "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.

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:

a. Jay R. Smith.
b. Zurn.
c. Josam.
d. Or Approved Equal.

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:

a. Jay R. Smith.
b. Zurn.
c. Josam.
d. Or Approved Equal.

2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Closure: Brass plug with tapered threads.
7. Adjustable Housing Material: Cast iron with threads, setscrews or other device.
8. Frame and Cover Material and Finish: Stainless steel.
9. Frame and Cover Shape: Round.
10. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers:

a. Jay R. Smith.
b. Zurn.
c. Josam.

d. Or Approved Equal.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. 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.

6. Wall Access, Cover Plate: Round, flat, chrome-plated stainless steel cover plate with screw.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings:

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 side inlet.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend a minimum 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

D. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

E. Expansion Joints:

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping.

1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in belowground piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 135 degrees.
3. Locate at minimum intervals of 100 feet.
4. Locate at base of each vertical soil and waste stack.

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 deep-seal traps on floor drains and other waste outlets, if indicated.

F. 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.

G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

H. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

I. Install vent caps on each vent pipe passing through roof.

J. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

K. Install wood-blocking reinforcement for wall-mounting-type specialties.

L. 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 221316 "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 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.

1. Nameplates and signs are specified in Section 220553 "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

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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.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains, FD-1:

1. Manufacturers:

a. J.R. Smith
b. Zurn
c. Or Approved Equal

2. Standard: ASME A112.6.3.
3. Body Material: Duco cast iron.
4. Seepage Flange: Required.
5. Anchor Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Top or Strainer Material: Stainless steel.
9. Top Shape: Square.
10. Top Loading Classification: Light Duty.
11. Trap Material: Cast iron.
12. Trap Pattern: Standard P-trap.
13. Trap Features: Trap-seal primer valve drain connection.

B. Cast-Iron Floor Drains, FD-2:

1. Manufacturers:

a. J.R. Smith
b. Zurn
c. Or Approved Equal

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Duco cast iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Top or Strainer Material: Gray iron.
10. Top Shape: Round.
11. Top Loading Classification: Medium Duty.
12. Trap Material: Cast iron.
13. Trap Pattern: Standard P-trap.
14. Trap Features: Trap-seal primer valve drain connection.

2.3 FLOOR SINKS

A. Cast-Iron Floor Sinks, FS-1:

1. Manufacturers:

a. J.R. Smith
b. Zurn
c. Or Approved Equal

2. Standard: ASME A112.6.7.
3. Pattern: Floor drain.
4. Body Material: Cast iron.
5. Anchor Flange: Required, with seepage holes.
6. Clamping Device: Required.
7. Outlet: Bottom, No-hub connection.
8. Coating on Interior Surfaces: Acid-resistant enamel.
9. Internal Strainer: Dome.
10. Internal Strainer Material: Aluminum.
11. Top Grate Material: Cast iron, loose.
12. Top of Body and Grate Finish: Nickel bronze grate with acid-resistant enamel coated interior.
13. Top Shape: Square.
14. Dimensions of Top Grate: 12 inch by 12 inch half grate.

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 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
   b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
   c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

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 1 inch above floor.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "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.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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 220553 "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 14

STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hubless, cast-iron soil pipe and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Requirements:

1. Section 334200 "Stormwater Conveyance" for storm drainage piping outside the building.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Hubless, cast-iron soil pipe and fittings.
2. Specialty pipe fittings.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For storm drainage 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 certificate is based and their installation requirements.

C. Field Quality-Control Reports: Inspection reports signed by authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.5 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of storm drainage service.
2. Do not proceed with interruption of storm drainage service without Construction Manager's written permission.

1.6 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are to be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: 10-foot head of water.

B. Seismic Performance: Storm drainage piping and support and installation to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

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 functional after the seismic event."
2. Component Importance Factor: 1.0.

2.2 PIPING MATERIALS

A. Piping materials to 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:

1. Charlotte Pipe.
2. Tyler Pipe.
3. Or Approved Equal.

B. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standards: ASTM A888 and CISPI 301.

C. CISPI, Hubless-Piping Couplings:

1. Manufacturers:

a. Anaco-Husky.
b. Charlotte.
c. Mission.
d. Or Approved Equal.

2. Standards: ASTM C1277 and CISPI 310.
3. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers:

a. Anaco-Husky 4000 Series
b. Or Approved Equal.

2. Standard: ASTM C1277 or ASTM C1540.
3. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

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 of 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. Standard: ASTM C1460.
b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
c. End Connections: Same size as and compatible with pipes to be joined.

4. Pressure Transition Couplings:

a. Standard: AWWA C219.
b. Description: Metal, sleeve-type couplings same size as pipes to be joined, and with pressure rating at least equal to and ends compatible with pipes to be joined.
c. Center-Sleeve Material: Stainless steel.
d. Gasket Material: Natural or synthetic rubber.
e. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2. Dielectric Flanges:
   a. Description:

      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 150 psig minimum at 180 deg F.
      4) End Connections: Solder-joint copper alloy and threaded ferrous.

2.5 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: High-density, crosslaminated polyethylene film of 0.004-inch minimum thickness.

C. Form: Tube.

D. Color: Natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

B. Install piping as indicated unless deviations from layout are approved on coordination drawings.

C. Install piping in concealed locations.

1. Piping installed in equipment rooms, service areas, and where indicated may be exposed.

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.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

L. 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.

M. Lay buried building 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.

N. Install piping at the following minimum slopes unless otherwise indicated.

1. Building Storm Drain: 1/8 inch per foot downward in direction of flow for piping NPS 3 and smaller; 1/8 inch per foot downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm Drainage Piping: 1/8 inch per foot downward in direction of flow.

O. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Ch IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.

P. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

Q. Plumbing Specialties:

1. Install cleanouts in storm drainage gravity-flow piping in accessible locations.

    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 221423 "Storm Drainage Piping Specialties."

2. Install drains in storm drainage gravity-flow piping.

a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Hubless, Cast-Iron Soil Piping Coupled Joints: Join in accordance with 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 in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
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. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

D. 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 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 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

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. In Aboveground Force-Main Piping: Fitting-type transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "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 and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install hangers for cast-iron piping, 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 and tubing within 12 inches of each fitting, valve, and coupling.

E. Support vertical cast-iron piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.

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 221423 "Storm Drainage Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "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.
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 storm drainage piping in accordance with 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.
c. From 15 minutes before inspection starts until completion of inspection, water level must not drop.
d. 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.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

3.10 PROTECTION

A. Protect piping and drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day and when work stops.

C. Repair damage to adjacent materials caused by storm drainage piping installation.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping shall be the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.

C. Underground storm drainage piping shall be the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.

END OF SECTION 22 14 14

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SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-purpose roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.

B. Related Requirements:

1. Section 076200 "Sheet Metal Flashing and Trim" for penetrations of roofs.
2. Section 078413 "Penetration Firestopping" for firestopping roof penetrations.

1.2 ACTION SUBMITTALS

A. Product Data:

1. General-purpose roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.

1.3 QUALITY ASSURANCE

A. Provide drainage piping specialties are to bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 GENERAL-PURPOSE ROOF DRAINS

A. Cast-Iron Roof Drains:

1. Cast-Iron, Large-Sump, General-Purpose Roof Drains: RD-1.

a. Manufacturers:

1) J.R. Smith No. 1010Y-R-C-U-AD
2) Zurn
3) Josam
4) Or Approved Equal.

b. Standard: ASME A112.6.4.

c. Body Material: Cast iron.
d. Dimension of Body: Nominal 14-to 16-inch diameter.
e. Dome Material: Aluminum.
f. Combination flashing ring and gravel stop.
g. Outlet: Bottom.
h. Outlet Type: No-hub.
i. Options:

1) Flow-control weirs.
2) Extension collars.
3) Underdeck clamp.
4) Expansion joint.
5) Sump receiver plate.
6) Vandal-proof dome.

2. Cast-Iron, Large-Sump, General-Purpose Roof Drains: OD-1.

a. Manufacturers:

1) J.R. Smith No. 1080Y-R-C-U
2) Zurn
3) Josam
4) Or Approved Equal.

b. Standard: ASME A112.6.4.
c. Body Material: Cast iron.
d. Dimension of Body: Nominal 14-to 16-inch diameter.
e. Dome Material: Aluminum.
f. Combination flashing ring and gravel stop.
g. Outlet: Bottom.
h. Outlet Type: No-hub.
i. Options:

1) Flow-control weirs.
2) Extension collars.
3) Underdeck clamp.
4) Expansion joint.
5) Sump receiver plate.
6) Vandal-proof dome.
7) Water Dam: 2 inches high.

2.2 PROMENADE ROOF DRAINS

A. Cast-Iron Promenade Roof Drains:

1. Cast-Iron, Small-Sump, Promenade Roof Drains: AD-1.

a. Manufacturers:

1) J.R. Smith
2) Zurn
3) Josam
4) Or Approved Equal.

b. Standard: ASME A112.6.4.
c. Body Material: Cast iron.
d. Dimension of Body: Nominal 8-inch diameter.
e. Dimension of Frame and Grate: Nominal 8 inches square.
f. Grate Material: Nickel-bronze alloy>.
g. Outlet: Bottom.
h. Outlet Type: No-hub.
i. Options:

1) Extension collars.
2) Underdeck clamp.
3) Expansion joint.
4) Sump receiver plate.
5) Vandal-proof grate.

2.3 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Metal Downspout Nozzles: DN-1.

1. Manufacturers:

a. J.R. Smith
b. Zurn
c. Josam
d. Or Approved Equal.

2. Description: Nozzle with wall flange and mounting holes to cover rough opening and serve as anchor.
3. Size: Same as connected downspout.
4. Material: Cast bronze or nickel bronze nozzle and flange.

2.4 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Cast-Iron Wall Cleanouts.

a. Manufacturers:

1) J.R. Smith.
2) Zurn.
3) Josam.
4) Or Approved Equal.

b. Standard: ASME A112.36.2M. Include wall access.
c. Size: Same as connected drainage piping.
d. Body: No-hub, cast-iron soil pipe test tee as required to match connected piping.
e. Closure Plug:

1) Material: Brass.
2) Head: Countersunk.
3) Drilled and threaded for cover attachment screw.
4) Size: Same as, or not more than, one size smaller than cleanout size.

f. Wall-Access Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.

2. Cast-Iron Test Tees.

a. Manufacturers:

1) J.R. Smith.
2) Zurn.
3) Josam.
4) Or Approved Equal.

b. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301.
c. Size: Same as connected drainage piping.
d. 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.
e. Closure Plug: Countersunk, brass.
f. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains in accordance with roof membrane manufacturer's written installation instructions at low points of roof areas.

1. Install flashing collar or flange of roof drain to 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 downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout nozzles at exposed bottom of conductors where they spill onto grade.

D. Install cleanouts in aboveground piping and building drain piping in accordance with the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 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 50 ft. for piping NPS 4 and smaller and 100 ft. for larger piping.
4. Locate cleanouts at base of each vertical storm piping conductor.

E. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

F. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

G. Install test tees in vertical conductors and near floor.

H. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

I. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221414 "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.

3.4 CLEANING

A. Clean piping specialties during installation and remove dirt and debris as work progresses.

3.5 PROTECTION

A. Protect piping specialties during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of each day and when work stops.

END OF SECTION 22 14 23

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SECTION 22 21 13

CONDENSATE DRAIN PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Piping joining materials.
3. Transition fittings.
4. Dielectric fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.

B. Qualification Data: For Installer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Piping components and installation are to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. Condensate-Drain Piping: 150 deg F.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88, Type M.

B. DWV Copper Tube: ASTM B306, Type DWV.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.

D. Wrought-Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4.

2.3 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B32, lead-free alloys.

B. Flux: ASTM B813, water flushable.

2.4 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.

2.5 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. Source Limitations: Obtain dielectric unions from single manufacturer.
2. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 125 psig minimum at 180 deg F.
c. End Connections: Solder-joint copper alloy and threaded ferrous. Solder joints are not to be used on pipe sizes greater than NPS 4.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Condensate-Drain Piping Installed Aboveground to be the Following:

1. Type M, drawn-temper copper tubing, wrought-copper DWV fittings, and soldered joints.

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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 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 piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install piping at a uniform grade of 0.1 percent downward in direction of flow.

M. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

N. Install branch connections to mains using wye-branch fittings in main pipe.

O. Install valves according to the following:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.14 "Check Valves for Plumbing Piping."

P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install shutoff valve immediately upstream of each dielectric fitting.

R. Comply with requirements in Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

S. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for identifying piping.

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

D. Threaded Joints: Thread 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 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.

3.4 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing."

B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for copper piping, 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 of each fitting and coupling.

E. Support vertical runs of copper piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 SYSTEM STARTUP

A. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.

3.8 FIELD QUALITY CONTROL

A. Prepare condensate drain piping in accordance with ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure is to be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on condensate drain piping:

1. Use ambient-temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Subject piping system to condensate drain test pressure that is not less than 1.5 times the system's working pressure. Test pressure is not to exceed maximum pressure for any vessel, pump, valve, or other component in system under test.
4. After condensate drain test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
5. Prepare written report of testing.

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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. 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.
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: Three years.

b. Expansion Tanks: Five years.

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: 1.5.

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:

1. Manufacturers:

   a. A.O. Smith
   b. Bradford White.
   c. Lochinvar.
   d. Or Approved Equal.

2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
3. Standard: UL 1453.
4. Storage-Tank Construction: Non-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 and Smaller: Threaded ends in accordance with ASME B1.20.1.
      2) NPS 2-1/2 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.
   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.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

1. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
2. 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.
3. 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.

4. Capacity and Characteristics:

    a. Working-Pressure Rating: 150 psig.

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 with ASME B1.20.1 pipe threads.

C. 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.

D. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.

E. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

F. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

G. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

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.

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 033000 "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 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 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate 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 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment." Section 220548.13 "Vibration 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 combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. 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.

F. 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 requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

G. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

H. Install thermometers on inlet and outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

I. Fill electric, domestic-water heaters with water.

J. Charge domestic-water expansion tanks with air to required system pressure.

K. 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 221116 "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 220553 "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.
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. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters. Training shall be a minimum of one hour.

END OF SECTION 22 33 00

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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.

B. Related Requirements:

1.2 DEFINITIONS

A. High-Efficiency Flush Volume: 1.28 gal. or less per flush.

B. 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.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

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 six 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:

1. Manufacturers:

   a. Kohler No. K-84325.
   b. American Standard No. 3351.101.
   c. Zurn
   d. Or Approved Equal.

2. Source Limitations: Obtain water closets from single source from single manufacturer.
3. Bowl:

   a. Material: Vitreous china.
   b. Type: Siphon jet.
   c. Style: Flushometer valve.
   d. Mounting Height: Standard.
   e. Rim Contour: Elongated.
   f. Spud Size and Location: NPS 1-1/2; top.
   g. Color: White.

4. Flushometer Valve: FV-1.
5. Toilet Seat: TS-1.
6. Support: Water-closet carrier.

B. Water Closets - Wall Mounted, Top Spud:

1. Manufacturers:

   a. Kohler No. K-84325.
   b. American Standard No. 3351.101.
   c. Zurn
   d. Or Approved Equal.

2. Source Limitations: Obtain water closets from single source from single manufacturer.
3. Bowl:

    a. Material: Vitreous china.
    b. Type: Siphon jet.
    c. Style: Flushometer valve.
    d. Mounting Height: ADA compliant.
    e. Rim Contour: Elongated.
    f. Spud Size and Location: NPS 1-1/2; top.
    g. Color: White.

4. Flushometer Valve: FV-1.
5. Toilet Seat: TS-1.
6. Support: Water-closet carrier.

2.3 FLUSHOMETER VALVES

A. Flushometer Valves - Diaphragm, Solenoid-Actuated, Exposed, Battery-powered: FV-1.

1. Manufacturers:

    a. Sloan No. Royal 111 SMO-1.28.
    b. Zurn.
    c. Kohler.
    d. Or Approved Equal.

2. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
3. Minimum Pressure Rating: 125 psig.
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. Actuator: Side or top mounted; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
9. 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.
10. Consumption: 1.28 gal. per flush.
11. Minimum Inlet: NPS 1.
12. Minimum Outlet: NPS 1-1/4.

2.4 TOILET SEATS

A. Toilet Seats: TS-1.

1. Manufacturers:

    a. Olsonite No. 95SSCT.
    b. Church
    c. Or Approved Equal.

2. Source Limitations: Obtain toilet seat from single source from single manufacturer.
3. Material: Plastic.

4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.
10. Surface Treatment: Antimicrobial.

2.5 SUPPORTS

A. Water-Closet Carrier:

1. Manufacturers:

a. Jay R. Smith MFG. Co.
b. Zurn Industries.
c. Or Approved Equal.

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.

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. 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 lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.

4. Install actuators in locations easily reachable for people with disabilities.
5. Install new batteries in battery-powered, electronic-sensor mechanisms.

C. Install toilet seats on water closets.

D. 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 220518 "Escutcheons for Plumbing Piping."

E. 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 079200 "Joint Sealants."

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 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "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

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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.

B. Related Requirements:

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. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors 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.

1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than six of each type.

PART 2 - PRODUCTS

2.1 WALL-HUNG URINALS

A. Urinals - Wall Hung, Back Outlet, Washout: UR-1.

1. Manufacturers:

   a. American Standard No. 6516001EC.
   b. Kohler.
   c. Zurn.
   d. Or Approved Equal.

2. Fixture:

   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5/CSA B45.15.
   b. Material: Vitreous china.
   c. Type: Washout with extended shields.
   d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
   e. Water Consumption: 0.125 gpf.
   f. Spud Size and Location: NPS 3/4, top.
   g. Outlet Size and Location: NPS 2, back.
   h. Color: White.

3. Flushometer Valve: FV-1.
4. Waste Fitting:

   a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
   b. Size: NPS 2.

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: Standard.

B. Urinals - Wall Hung, Back Outlet, Washout: Accessible UR-2.

1. Manufacturers:

   a. American Standard No. 6516001EC.
   b. Kohler.
   c. Zurn
   d. Or Approved Equal.

2. Fixture:

   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5/CSA B45.15.
   b. Material: Vitreous china.
   c. Type: Washout with extended shields.
   d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
   e. Water Consumption: 0.125 gpf.
   f. Spud Size and Location: NPS 3/4, top.
   g. Outlet Size and Location: NPS 2, back.
   h. Color: White.

3. Flushometer Valve: FV-1.
4. Waste Fitting:

    a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
    b. Size: NPS 2.

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: Handicapped/elderly according to ICC A117.1.

2.2 URINAL FLUSHOMETER VALVES

A. Flushometer Valves – Diaphragm, Solenoid-Actuator, Diaphragm: Exposed, Battery-powered: FV-1.

1. Manufacturers:

    a. Kohler No. K-10UH00D20-CP.
    b. Sloan
    c. Zurn
    d. Or Approved Equal.

2. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
3. Minimum Pressure Rating: 125 psig.
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 1.
12. Minimum Outlet: NPS 3/4.

2.3 SUPPORTS

A. Type I Urinal Carrier:

1. Manufacturers:

    a. Jay R. Smith MFG. Co.
    b. Zurn Industries.
    c. Or Approved Equal.

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.
3. Use carriers without waste fitting for urinals with tubular waste piping.
4. Use chair-type carrier supports with rectangular steel uprights for accessible 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.
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 220518 "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 079200 "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 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "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.

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

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SECTION 22 42 16.13

COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vitreous-china, wall-mounted lavatories.
2. Lavatory systems.
3. Automatically operated lavatory faucets.
4. Supply fittings.
5. Waste fittings.
6. Lavatory supports.

1.2 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. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.4 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 017823 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments of automatic faucets.

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. 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, WALL-MOUNTED LAVATORIES

A. Lavatory - Rectangular, Vitreous China, Wall Mounted, with Back, L-1:

1. Manufacturers:

   a. Nameek's No. Scarabeo 3004
   b. Kohler.
   c. American Standard.
   d. Or Approved Equal.

2. Fixture:

   a. Standard: ASME A112.19.2/CSA B45.1.
   b. Type: For wall hanging.
   c. Nominal Size: Rectangular, 23.5 by 10 inches.
   d. Faucet-Hole Location: Top.
   e. Color: White.
   f. Mounting Material: Chair carrier.

3. Faucet: F-1.
4. Support: Type II, concealed-arm lavatory carrier.
5. Lavatory Mounting Height: Handicapped/elderly in accordance with ICC A117.1.

2.2 LAVATORY SYSTEMS

A. Lavatory System - Multiple Stations L-2:

1. Manufacturers:

   a. Sloan No. AER-DEC
   b. Kohler.
   c. American Standard
   d. Or Approved Equal.

2. Standards: ASME A112.18.1/CSA B125.1, ANSI A117.1, CSA B45.5/IAPMO Z124, NSF 61, NSF 372, and UPC, IPC, and GREENGUARD Certified.
3. Fixture:

   a. Standard: CSA B45.8/IAPMO Z403 and ICC A117.1.
   b. Type: Straight front and side aprons with straight back.
   c. Overall Countertop Size: Custom Size. See Architect drawings for dimensions.
   d. Faucet-Hole Punching (per Station): See Architect drawings for hole configuration
   e. Drain Type: Slot drain.
   f. Color: See architectural drawings.

4. 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.
5. Bowl(s) and Counter:

    a. Material: Solid-surface or natural quartz surface.
    b. Height to Rim: 34 inches above floor.
    c. Mounting: Wall hung.
    d. Number of Stations: Two.
    e. Drain: Grid with NPS 1-1/2 tailpiece, each bowl.

6. Faucets:

    a. Type: Manufacturer's standard, chrome-plated solid brass, each bowl.
    b. Control: Battery-powered, sensor-actuated mixing valve with check stops for each user station.

7. Mixer Point-of-Use:

    a. Material: Solid bimetal (bronze, brass, stainless steel).
    b. Security: Hot limit stop set to a maximum of 109.4 deg F.
    c. Set: Screwdriver adjustment temperature dial with scale: Cold-hot.

8. Lavatory System Mounting: Off floor on wall brackets and frame enclosure.
9. Supply Fittings:

    a. Piping: NPS 1/2 copper tubing, each bowl.
    b. Valves: Shutoff valve on each supply.
    c. Supply Piping: From wall.

10. Waste Fittings:

    a. Standard: ASME A112.18.2/CSA B125.2.
    b. Trap and Drain Piping: NPS 1-1/2, each bowl.

B. Lavatory System - Multiple Stations L-3:

1. Manufacturers:

    a. Sloan No. AER-DEC
    b. Kohler.
    c. American Standard
    d. Or Approved Equal.

2. Standards: ASME A112.18.1/CSA B125.1, ANSI A117.1, CSA B45.5/IAPMO Z124, NSF 61, NSF 372, and UPC, IPC, and GREENGUARD Certified.
3. Fixture:

    a. Standard: CSA B45.8/IAPMO Z403 and ICC A117.1.
    b. Type: Straight front and side aprons with straight back.
    c. Overall Countertop Size: Custom Size. See Architect drawings for dimensions.
    d. Faucet-Hole Punching (per Station): See Architect drawings for hole configuration
    e. Drain Type: Slot drain.
    f. Color: See architectural drawings.

4. 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.
5. Bowl(s) and Counter:

    a. Material: Solid-surface or natural quartz surface.
    b. Height to Rim: 34 inches above floor.
    c. Mounting: Wall hung.
    d. Number of Stations: Three.
    e. Drain: Grid with NPS 1-1/2 tailpiece, each bowl.

6. Faucets:

    a. Type: Manufacturer's standard, chrome-plated solid brass, each bowl.
    b. Control: Battery-powered, sensor-actuated mixing valve with check stops for each user station.

7. Mixer Point-of-Use:

    a. Material: Solid bimetal (bronze, brass, stainless steel).
    b. Security: Hot limit stop set to a maximum of 109.4 deg F.

8. Lavatory System Mounting: Off floor on wall brackets and frame enclosure.
9. Supply Fittings:

    a. Piping: NPS 1/2 copper tubing, each bowl.
    b. Valves: Shutoff valve on each supply.
    c. Supply Piping: From wall.

10. Waste Fittings:

    a. Standard: ASME A112.18.2/CSA B125.2.
    b. Trap and Drain Piping: NPS 1-1/2, each bowl.

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: Battery Powered Electronic Sensor Operated, Mixing, L-1:

1. Manufacturers:

    a. Chicago Faucets No. E80-A11H-17ABCPT.
    b. Kohler
    c. Zurn
    d. Or Approved Equal.

2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.

3. General: Include hot- and cold-water indicators; 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: 0.5 gpm.
8. Mounting Type: Deck, concealed.
9. Spout: Rigid type.
10. Spout Outlet: Aerator.

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 or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:

1. NPS 3/8.
2. Chrome-plated, soft-copper flexible tube riser.

2.5 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2 by NPS 1-1/4.
2. Material:

a. Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.

2.6 LAVATORY SUPPORTS

A. Lavatory Carrier:

1. Manufacturers:

a. Jay R. Smith MFG. Co.

b. Zurn Industries.
c. Or Approved Equal.

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 220518 "Escutcheons for Plumbing Piping."

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 079200 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "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 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 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 in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 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.

3.6 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

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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.

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 and furnished specialties and accessories.

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.

1.6 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 - Enameled Cast Iron, Floor Mounted: SS-1.

1. Manufacturers:

   a. American Standard No. 7745.811.
   b. Kohler.
   c. Zurn.
   d. Or Approved Equal.

2. Source Limitations: Obtain sinks from single source from single manufacturer.
3. Fixture:

   a. Standard: ASME A112.19.1/CSA B45.2.
   b. Style: With front apron and raised back.
   c. Nominal Size: 28 by 28 inches.
   d. Color: White.
   e. Drain: Grid with NPS 3 outlet.
   f. Rim Guard: Coated wire.

4. Faucet: F-2.

2.2 KITCHEN/UTILITY SINKS

A. Kitchen/Utility Sinks - Stainless Steel, Counter Mounted: S-1.

1. Manufacturers:

   a. Just Manufacturing No. SLADA1815A50-J.
   b. Elkay.
   c. Acorn Eng.
   d. Or Approved Equal.

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, self-rimming, sound-deadened unit with ledge back.
   c. Number of Compartments: One.
   d. Overall Dimensions: 17-1/2”x15”x5” deep.
   e. Material: 18 gauge, Type 304 stainless steel.
   f. Compartment:

      1) Dimensions: 12”x12”x5” deep.

2) Drain: Grid with NPS 1-1/2 tailpiece.
3) Drain Location: Center.
4) Depth: Wheelchair accessible.

4. Faucet(s): F-1.

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, ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.

6. Waste Fittings:

a. Standard: ASME A112.18.2/CSA B125.2.
b. Trap(s):

1) Size: NPS 1-1/2.
2) Material:

a) Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

7. Mounting: On counter with sealant.

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.

B. Commercial Sink Faucets - Manual Type: Single-handle mixing, F-1.

1. Manufacturers:

a. Chicago Faucets No. 2302-E35ABCP.
b. American Standard.
c. T&S Brass.
d. Or Approved Equal.

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 Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.
6. Finish: Polished-chrome.
7. Mounting Type: Deck, concealed.
8. Valve Handle(s): Lever.
9. Spout Type: Rigid/Swing gooseneck.
10. Spout Outlet: Aerator.

C. Commercial Service Sink Faucets - Manual Type: F-2.

1. Manufacturers:

a. Chicago Faucets No. 897-CP.
b. American Standard.
c. T&S Brass.
d. Or Approved Equal.

2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Description: Wall/back mounted, brass body, with integral service stops, checks, spout with bucket/pail hook, 3/4-inch hose thread end, integral vacuum breaker, inlets 8 inches 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. Cartridges: Ceramic.
d. Brace: Adjustable top brace.

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 or compression valve with inlet connection matching supply piping.

E. Operation: Wheel handle.

F. Risers:

1. NPS 3/8.
2. ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.

2.5 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2.
2. Material:

a. Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

2.6 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000 psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

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. Install wall-mounted sinks at accessible mounting height in accordance with ICC A117.1.

D. Set floor-mounted sinks in leveling bed of cement grout.

E. 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 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

2. Install stops in locations where they can be easily reached for operation.

F. 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 220518 "Escutcheons for Plumbing Piping."

G. 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 079200 "Joint Sealants."

H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "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 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Install new batteries in battery-powered, electronic-sensor mechanisms.

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. Shop Drawings:

1. Include diagrams for power wiring.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For pressure water coolers 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.

1. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no fewer than 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

A. Pressure Water Coolers - Inwall Frame/Plate, Wall-Mounted, Stainless Steel: DF-1.

1. Manufacturers:

   a. Elkay No. LZWS-LRPBM28K
   b. Haws Company.
   c. Murdock MFG.
   d. Or Approved Equal.

2. Source Limitations: Obtain inwall frame/plate, wall-mounted, stainless steel, pressure water coolers from single source from single manufacturer.
3. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
4. Control: Push button>.
5. Bottle Filler: Sensor activation. Fill rate 0.5 to 1.5.
6. Drain: Grid with NPS 1-1/4 tailpiece.
7. Supply: NPS 3/8 with shutoff valve.
8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
9. Filter: One or more water filters with capacity sized for unit peak flow rate.
10. 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.
11. Support: Provide manufacturer's support frame for attachment to substrate.
12. Water-Cooler Mounting Height: High/low - standard/accessible in accordance with ICC A117.1.
13. Capacities and Characteristics:

    a. Cooled Water: 8 gph.
    b. Ambient-Air Temperature: 90 deg F.

c. Inlet-Water Temperature: 80 deg F.
d. Cooled-Water Temperature: 50 deg F.
e. Electrical Characteristics:

1) Volts: 120 V ac.
2) Phase: Single.
3) Hertz: 60 Hz.

2.3 SUPPORTS

A. Water-Cooler Carrier:

1. 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.

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. Set freestanding, pressure water coolers on floor.

C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

D. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers, and bottle filling stations to mounting frames.

E. 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 220523.12 "Ball Valves for Plumbing Piping"

F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

G. 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 220518 "Escutcheons for Plumbing Piping."

H. 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 079200 "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 221116 "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 220523.12 "Ball Valves for Plumbing Piping".

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

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 with a black background and engraved white letters at least 1/2 inch 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 00 00

GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. Basic mechanical requirements specifically applicable to Division 23 Sections.

B. Work includes but is not necessarily limited to the following:

1. Labor, materials, services, equipment, and appliances required for completion of tasks as indicated on drawing or in specification or as inherently necessary to prepare spaces and systems for new installations as follows:

a. Heating, ventilating and air conditioning systems and equipment
b. Testing, adjusting and balancing

1.2 DRAWINGS AND SPECIFICATIONS

A. Drawings accompanying these Specifications show intent of Work to be done. Specifications shall identify quality and grade of installation and where equipment and hardware is not particularly specified. Contractor shall provide submittals for all products and install them per manufacturers' recommendations, and in a first class manner.

B. Examine Drawings and Specifications for elements in connection with this Work; determine existing and new general construction conditions and be familiar with all limitations caused by such conditions.

C. Plans are intended to show general arrangement and extent of Work contemplated. Exact location and arrangement of parts shall be determined after the Owner has reviewed equipment, as Work progresses, to conform in best possible manner with surroundings, and as directed by the Owner's Representative.

D. Contract Documents are in part diagrammatic and intended to show the scope and general arrangement of the Work under this Contract. The Contractor shall follow these drawings in laying out the equipment, piping and ductwork. Drawings are not intended to be scaled for roughing in measurements or to serve as shop drawings. Where job conditions require minor changes or adjustments in the indicated locations or arrangement of the Work, such changes shall be made without change in the Contract amount.

E. Follow dimensions without regard to scale. Where no figures or notations are given, the Plans shall be followed.

1.3 UTILITIES

A. Location and sizes of electrical, mechanical and plumbing service facilities are shown in accordance with data secured from existing record drawings and site observations. Data shown are offered as an estimating guide without guarantee of accuracy. Check and verify all data given and verify exact location of all utility services pertaining to Work prior to excavation or performing Work.

1.4 APPLICABLE REFERENCE STANDARDS, CODES AND REGULATIONS

A. Meet requirements of all state codes having jurisdiction.

B. State of California Code of Regulations:

1. Title 8, Industrial Relations
2. Title 19, State Fire Marshal Regulations
3. 2022 California Building Code (CBC), Title 24, Part 2
4. 2022 California Electrical Code, Title 24, Part 3
5. 2022 California Mechanical Code, Title 24, Part 4
6. 2022 California Plumbing Code, Title 24, Part 5
7. 2022 California Energy Code, Title 24, Part 6
8. 2022 California Fire Code, Title 24, Part 9
9. 2022 California Standards Code, Title 24, Part 12

C. Additional Referenced Standards:

1. AABC Associated Air Balance Council
2. AMCA Air Moving and Conditioning Association
3. ARI Air-Conditioning and Refrigeration Institute
4. ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers
5. ASME American Society of Mechanical Engineers
6. ASTM American Society for Testing and Materials
7. NEMA National Electrical Manufacturer's Association
8. NFPA National Fire Protection Association Standards
9. PDI Plumbing and Drainage Institute
10. UL Underwriters Laboratories

D. Codes and ordinances having jurisdiction over Work are minimum requirements; but, if Contract Documents indicate requirements, which are in excess of those minimum requirements, then requirements of the Contract Documents shall be followed. Should there be any conflicts between Contract Documents or codes or any ordinances having jurisdiction, report these to the Owner's Representative.

E. Obtain permits, and request inspections from authority having jurisdiction.

1.5 PROJECT AND SITE CONDITIONS

A. The arrangement of and connection to equipment shown on the Drawings is based upon information available and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic and some features of the illustrated equipment installations may require revision to meet actual equipment installation requirements. Structural supports, housekeeping pads, piping connections and adjacent equipment may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions or alterations.

B. Examine all Drawings and Specifications to be fully cognizant of all work required under this Division.

C. Examine site related work and surfaces before starting work of any Section.

D. Install Work in locations shown on approved Drawings, unless prevented by Project conditions.

E. Prepare shop drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission from the Owner's Representative before proceeding.

1.6 COOPERATION WITH WORK UNDER OTHER DIVISIONS

A. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.

B. Work under this Division shall follow general building construction closely. Set pipe sleeves and inserts and verify that openings for chases and pipes are provided.

C. Work with other trades in determining exact location of outlets, pipes, and pieces of equipment to avoid interference with lines required to maintain proper installation of Work.

D. Make such progress in the Work to not delay work of other trades.

E. Mechanical Work shall have precedence over the other in the following sequence:

1. Soil and waste piping
2. Hydronic piping
3. Ductwork
4. Domestic water piping
5. Fire sprinkler piping

1.7 DISCREPANCIES

A. The Contractor shall check all Drawings furnished him immediately upon their receipt and shall promptly notify the Owner's Representative of any discrepancies. Figures marked on Drawings shall in general be followed in preference to scale measurements. Piping and instrumentation diagrams shall in general govern floor plans and sections. Large-scale drawings shall in general govern small-scale drawings.

B. Where requirements between Drawings and Specifications conflict, the more restrictive provisions shall apply.

C. If any part of the Specifications or Drawings appears unclear or contradictory, apply to Owner's Representative for interpretation and decision as early as possible, including during bidding period. Do not proceed with such work without Owner Representatives decision. Beginning work of any Section constitutes acceptance of conditions.

1.8 CHANGES

A. The Contractor shall be responsible to make and obtain approval from the Owner's Representative for all necessary adjustments in piping and equipment layouts as required to accommodate the relocations of equipment and/or devices, which are affected by any approved authorized changes or Product substitutions. All changes shall be clearly indicated on the "Record" drawings.

1.9 SUBMITTALS

A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.

B. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.

C. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

D. Note that prior to acceptance of submittals for review, a submittal schedule shall be submitted to the Owner’s Representative.

E. Submit all Division 23 shop drawings and product data grouped and referenced by the specification technical section number in one complete submittal package.

F. Shop Drawings:

1. Include installation details of equipment indicating proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.
2. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
3. If equipment is rejected, revise drawings to show acceptable equipment and resubmit.
4. Whenever more than one (1) manufacturer’s product is specified, the first named product is the basis of design used in the Drawings and the use of alternate-named manufacturer’s products or substitutes may require modifications to the design.
5. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the Owner’s Representative bearing the Owner's Representative stamp of "Reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site at the request of the Owner’s Representative without additional compensation.
6. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.
7. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or American Water Works Association (AWWA), submit proof of such conformance to the Owner Representative for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the Owner Representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.
8. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.
9. Certificates of Compliance or Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this Contract. Pre-printed certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

1.10 PROJECT RECORD DOCUMENTS

A. All changes, deviations and information recorded on the “Project Record Drawings” set during Construction shall be redrafted onto the latest version of AutoCAD or Revit, where applicable.

B. Submit completed shop drawings to the Owner prior to completion in AutoCAD format.

C. Contractor hand marked or drafted redlined “Project Record Drawings” will not be accepted.

1.11 OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel.

1.12 MANUFACTURER'S RECOMMENDATIONS

A. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

1.13 DELIVERY AND STORAGE

A. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B P, Appendix I, titled "Equipment Storage and Maintenance During Construction." Replace damaged or defective items with new items.

1.14 GUARANTEE

A. Except as may be specified under other sections in the Specifications, guarantee all equipment furnished under the Specifications for a period of one year from date of project acceptance against defective workmanship and material and improper installation. Upon notification of failure, correct deficiency immediately and without cost to the Owner.

B. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to the Owner for their service agency as directed.

1.15 COMMISSIONING

A. Division 23 will be responsible to carry out the commissioning requirements.

B. Management:

1. The Commissioning Agent (CA) is hired directly by the Owner.
2. The CA directs and coordinates the commissioning activities and the reports to the Owner’s Representative.
3. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.
4. All contractors shall include the cost of commissioning in the contract price. The contractors should be prepared to provide commissioning assistance and follow through until all the commissioned systems have been signed off by the commissioning provider and the Owner Representative.

5. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.

C. Commissioning requires the participation of Division 23 Mechanical Contractor to work to ensure that all systems are operating in a manner consistent with the Design Intent.

D. The mechanical contractor is responsible for assisting the commissioning agent throughout the entire commissioning process. The work is not complete until the commissioning agent and the Owner Representative has signed off on the commissioned systems.

1.16 COMMISSIONING RESPONSIBILITIES

A. Mechanical Contractor: The commissioning responsibilities applicable to the mechanical contractor are as follows (all references apply to commissioned equipment only):

1. All contractors shall include the cost of commissioning in the contract price. The contractors should be prepared to provide commissioning assistance and follow through until all the commissioned systems have been signed off by the commissioning provider and the Owner Representative.
2. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
3. General Contractor shall attend a commissioning kickoff meeting and other meetings necessary to facilitate the commissioning process.
4. General Contractor shall provide the Commissioning Provider with normal cut sheets and shop drawing submittals of commissioned equipment.
5. General Contractor shall provide additional requested documentation, prior to normal O&M manual submittals, to the Commissioning Provider for development of start-up and functional testing procedures.

    a. Typically, this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Provider.
    b. The Commissioning Provider may request further documentation necessary for the commissioning process.

6. General Contractor shall provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the Commissioning Provider for review.
7. Sub-Contractors and design engineers shall assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
8. General Contractor shall provide limited assistance to the Commissioning Provider in preparing the specific functional performance test procedures. Sub-Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
9. General Contractor shall develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the pre-functional checklists from the Commissioning Provider for all commissioned equipment. Submit to Commissioning Provider for review prior to startup.
10. During the startup and initial checkout process, execute the mechanical related portions of the pre-functional checklists for all commissioned equipment.
11. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Commissioning Provider.

12. Address current Engineer of Record punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.
13. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.
14. Provide skilled technicians to perform functional performance testing under the direction of the Commissioning Provider. Assist the Commissioning Provider in interpreting the monitoring data, as necessary.
15. Correct deficiencies (differences between specified and observed performance) as interpreted by the Commissioning Provider, Owner's Representative and Engineer of Record and retest the equipment.
16. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
17. During construction, maintain as-built redline drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning.
18. Provide training of the Owner Representative's operating staff using expert qualified personnel, as specified.
19. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
20. Execute any deferred functional performance testing, witnessed by the Commissioning Provider, according to the specifications.
21. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

B. Mechanical Contractor. The responsibilities of the HVAC mechanical contractor, during construction and acceptance phases in addition to those listed in (A) are:

1. Provide startup for all HVAC equipment, except for the building automation control system.
2. Assist and cooperate with the TAB contractor and Commissioning Provider by:

    a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
    b. Including cost of sheaves and belts that may be required by TAB.
    c. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Provide an approved plug.
    d. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.

3. Install a P/T plug at each water sensor, which is an input point to the control system.
4. List and clearly identify on the as-built drawings the locations of all air-flow stations.
5. Prepare a preliminary schedule for pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the Commissioning Provider. Update the schedule as appropriate.
6. Notify the Owner's Representative when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the Owner's Representative or Commissioning Provider, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the Commissioning Provider has the scheduling information needed to efficiently execute the commissioning process.

PART 2 - PRODUCTS (Not Applicable).

PART 3 - EXECUTION

3.1 GENERAL

A. Obtain and pay for all permits and inspections, including any independent testing required to verify standard compliance, and deliver certificates for same to the Owner's Representative.

3.2 WORK RESPONSIBILITIES

A. The drawings indicate diagrammatically the desired locations or arrangement of piping, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions.

B. The Contractor is responsible for the correct placing of Work and the proper location and connection of Work in relation to the work of other trades. Advise appropriate trade as to locations of access panels.

C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the ductwork, piping, etc. and work directly connected to same is installed and no extra materials are required.

D. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.

E. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any work, carefully check and verify all dimensions, sizes, etc. with the drawings to see that the equipment will fit into the spaces provided without violation of applicable codes.

F. Should any changes to the Work indicated on the Drawings or described in the Specifications be necessary in order to comply with the above requirements, notify the Owner immediately and cease work on all parts of the contract, which are affected until approval for any required modifications to the construction has been obtained from the Owner.

G. Be responsible for any cooperative work, which must be altered due to lack of proper supervision or failure to make proper provisions in time. Such changes shall be under direction of the Owner and shall be made to his satisfaction. Perform all Work with competent and skilled personnel.

H. All work, including aesthetic as well as mechanical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.

I. Replace or repair, without additional compensation, any Work, which, in the opinion of the Owner, does not comply with these requirements.

3.3 PAINTING

A. Refer to Division 09 for additional requirements.

B. Factory Applied:

1. Mechanical equipment shall have factory-applied painting systems, which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.
2. Refer to individual sections of this Division for more stringent requirements.

C. Field Applied:

1. Paint all mechanical equipment as required to touch up, to match finish on other equipment in adjacent spaces or to meet safety criteria.
2. Paint all exposed, uninsulated mechanical piping, valves, supports, hangers and appurtenances. Provide minimum 5 mils dry film thickness.
3. Paint ductwork flat black that are visible behind air outlets and inlets.
4. Paint all exposed ductwork, ductwork supports, hangers and appurtenances.
5. Paint shall be a high-performance polyurethane enamel coating system.

    a. Acceptable paint manufacturers include Ameron, Tnemec or engineer approved equal.
    b. Acceptable primer manufacturers include Ameron Amershield VOC, Tnemec's Series 1075 (1074) Endura-Shield, semi-gloss (gloss) sheen or equal.
    c. Provide minimum 5 mils dry film thickness.

3.4 COMMISSIONING TRAINING OF OWNER'S REPRESENTATIVE PERSONNEL

A. The General Contractor shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.

B. The Commissioning Provider shall be responsible for reviewing the content and adequacy of the training of Owner's Representative personnel for commissioned equipment.

C. Mechanical Contractor. The mechanical contractor shall have the following training responsibilities:

1. Provide the Commissioning Provider and A/E with a training plan at least two weeks before the planned training.
2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment.
3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
6. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

8. Training shall include:

   a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
   b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
   c. Discussion of relevant health and safety issues and concerns.
   d. Discussion of warranties and guarantees.
   e. Common troubleshooting problems and solutions.
   f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
   g. Discussion of any peculiarities of equipment installation or operation.
   h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.

9. Hands-on training shall include start-up, operation in all modes possible, including manual, shutdown and any emergency procedures and preventative maintenance for all pieces of equipment.
10. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
11. Training shall occur after functional testing is complete, unless approved otherwise by the Owner's Representative.

END OF SECTION 23 00 00

SECTION 23 05 00

COMMON WORK RESULTS 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. This Section includes the following:
1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. Equipment installation requirements common to equipment sections.
8. Painting and finishing.
9. Supports and anchorages.

1.3 DEFINITIONS

A. 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, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. 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.

F. The following are industry abbreviations for plastic materials:
1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PE: Polyethylene plastic.
3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. 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.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 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.

1.7 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. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not 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.

3.2 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.3 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.

3.4 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.

3.5 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.

END OF SECTION 23 05 00

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 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 above sea level.

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 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers:
1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motor shall be an electronic commutation (EC) motor specifically designed for HVAC applications. AC induction type motors are not acceptable.

B. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase.

C. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown).

D. Motor shall be a minimum of 85% efficient at all speeds.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13

SECTION 23 05 17

SLEEVES AND SLEEVE SEALS FOR HVAC 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. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

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. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve (or cored concrete hole).

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: Glass reinforced plastic.

3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

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 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.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "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.

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 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: Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6 Galvanized-steel-pipe sleeves with sleeve-seal system

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6 Galvanized-steel-pipe sleeves with sleeve-seal system

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

END OF SECTION 23 05 17

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SECTION 23 05 23

GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Bronze gate valves.
3. Iron gate valves.
4. Bronze globe valves

B. Related Sections:

1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.4 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.5 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 gate and globe valves closed to prevent rattling.
4. Set ball valves open to minimize exposure of functional surfaces.
5. 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.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

E. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES (SIZES ½" THROUGH 2")

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Milwaukee Valve Company.
b. NIBCO INC.
c. Watts Regulator Co.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.3 BRONZE GATE VALVES (SIZE 2” AND SMALLER)

A. Class 125, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.
b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

2.4 IRON GATE VALVES (SIZES 2-1/2” THROUGH 12”)

A. Class 125, OS&Y, Iron Gate Valves. (Size 3” and Larger):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
e. NIBCO INC.

2. Description:

a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Disc: Solid wedge.

h. Packing and Gasket: Asbestos free.

2.5 BRONZE GLOBE VALVES (SIZES 2” AND SMALLER)

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.
b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following AND confirm valve type with Owner prior to installation:

1. Shutoff Service: Ball, or gate valves.

3.2 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two-piece, full port, bronze with stainless-steel trim.
3. Bronze Gate Valves: Class 125, RS.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
3. High-Performance Butterfly Valves: Class 150, single flange.
4. Iron Gate Valves: Class 125, OS&Y
5. Iron, Center-Guided Check Valves: Class 125, compact-wafer and globe, metal resilient seat.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC 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. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Equipment supports.

B. Related Sections:

1. Division 05 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 23 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC 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. See Division 23 “Seismic Restraint of Suspended Mechanical Utilities”.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following: include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
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 California professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
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.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

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. Allied Tube & Conduit
   b. Cooper B-Line, Inc.
   c. Flex-Strut Inc.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut Corporation; Tyco International, Ltd.
   g. Wesanco. Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
7. Metallic Coating: Hot-dipped galvanized for outdoor or corrosive environments.
8. Paint Coating: Epoxy for dry indoor locations.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig 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 beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, steel 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. Outdoor or wet areas: stainless steel anchors.
2. Indoor, dry areas: Zinc-coated steel anchors.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, 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, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. 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 A 36/A 36M, 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 mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. 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.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. 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 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.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. 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.

M. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating below or 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 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 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
6. Shield and insert lengths may be reduced to a minimum of 6” long (3” in each direction from the centerline of the hanger) at locations where obstructions prevent the shield and insert from being installed to the full length. All other locations shall conform to the specifications.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 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.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as 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.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 "Exterior Painting"

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will be installed outdoors or in wet locations.

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, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

F. Use thermal-hanger shield inserts for insulated piping and tubing.

G. 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.
2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
4. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
6. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
10. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
11. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
12. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
13. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
14. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

H. 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.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

I. 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 up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F 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.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

J. 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-joist 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.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

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.

K. 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.

L. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

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.
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.

M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

O. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29

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SECTION 230548 - VIBRATION AND SEISMIC CONTROLS 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. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Housed-spring isolators.
4. Housed-restrained-spring isolators.
5. Spring hangers.
6. Vibration isolation equipment bases.
7. Restrained isolation roof-curb rails.

B. Related Requirements:

1. Section 210548 "Vibration and Seismic Controls for Fire Suppression" for devices for fire-suppression equipment and systems.
2. Section 220548 "Vibration and Seismic Controls for Plumbing" for devices for plumbing equipment and systems.

1.3 DEFINITIONS

IBC: International Building Code. ASCE 7: Minimum Design Loads for Buildings & Other Structures.

ICC-ES: ICC-Evaluation Service.

1.4 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. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
    b. Annotate to indicate application of each product submitted and its compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

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. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified California professional engineer responsible for their preparation.

2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic and wind forces required to select vibration isolators and seismic and wind restraints and for designing vibration isolation bases.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

3. 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 that riser system was examined for excessive stress and that none exists.

4. Seismic(- and Wind)-Restraint Details

a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the 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 with requirements in other Sections for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 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. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: 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 and that is acceptable to authorities having jurisdiction.

B. Comply with seismic & wind-restraint requirements in ASCE 7 unless requirements in this Section are more stringent.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified California professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: Refer to Structural engineering plans and calculations.

2. Building Use or Occupancy Category: Refer to Structural engineering plans and calculations.

3. Minimum 19 lb/sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: Refer to Structural engineering plans and calculations.

2. Assigned Seismic or Building Risk Category as Defined in ASCE 7 and the IBC: Refer to Structural engineering plans and calculations.

a. Component Importance Factor: Refer to Structural engineering plans and calculations.

b. Component Response Modification Factor: Per Table 13.6-1 of ACE 7. Refer to

Structural engineering plans and calculations.

c. Component Amplification Factor: Per Table 13.6-1 of the ASCE 7. Refer to Structural engineering plans and calculations.

3. Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. M.W. Sausse & Co., Inc./Vibrex.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, 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.

5. Surface Pattern: Smooth, Ribbed or Waffle pattern.

6. Load-bearing steel plates adhered to pads.

7. Sandwich-Core Material: Elastomeric.

   a. Surface Pattern: Smooth, Ribbed Waffle pattern.

   b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. M.W. Sausse & Co., Inc./Vibrex.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.

2. Mounting Plates:

   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.

   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. M.W. Sausse & Co., Inc./Vibrex.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.

2. Minimum Additional Travel: 50 percent of the required deflection at rated load.

3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5. Two-Part Telescoping Housing: A steel top and bottom frame separated by elastomeric material and enclosing the spring isolators.

   a. Drilled base housing for bolting to structure. Bases shall limit floor load to 500 psig.

   b. Top housing with either attachment and leveling bolt, threaded mounting holes and internal leveling device or elastomeric pad.

2.5 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Housing:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. M.W. Sausse & Co., Inc./Vibrex.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.

2. Two-Part Housing: A steel top and bottom assembly separated integrated snubbers providing a maximum 1/4" airgap between contact points lined and elastomeric material. Snubbers are adjustable or non-adjustable and must limit movement in all directions.

   a. Drilled base housing for bolting to structure. Bases shall limit floor load to 500 psig.

   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

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.

2.6 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. M.W. Sausse & Co., Inc./Vibrex.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment (+/- 15 Degrees from the vertical) without binding or reducing isolation efficiency.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

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. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

7. Adjustable Vertical Stop: Steel washer with neoprene washer limit stop on lower threaded rod.

8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.7 VIBRATION ISOLATION EQUIPMENT BASES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. M.W. Sausse & Co., Inc./Vibrex.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.

B. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch 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 minimum ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.

3. Support Brackets: For use with height saving applications, and are to be factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch 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 minimum ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: For use with height saving applications, and are to be factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Concrete Inertia Base: Factory-fabricated or field-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 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 minimum ASTM A 36/A 36M. Bases shall 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.

2.8 RESTRAINED ISOLATION ROOF-CURB RAILS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

    a. M.W. Sausse & Co., Inc./Vibrex.
    2. Kinetics Noise Control, Inc.
    3. Mason Industries, Inc.

B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

C. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.

D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

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 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 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 and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in "Cast-in-Place Concrete" Section.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

D. 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. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Piping Restraints:

1. Comply with requirements in ASCE 7.

2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.

3. Brace a change of direction longer than 12 feet.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

I. 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.

J. 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.

K. Post-installed 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 the 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 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. Adhesive Anchors: 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.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Provide anchors as required on either side of the flexible connection to prevent damage to the pipe. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

3.5 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. 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 post-connection 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 at least four of each type and size of installed anchors and fasteners selected by Structural or Civil Engineer of Record.

5. Test to 90 percent of rated proof load of device.

6. Measure isolator restraint clearance and that it does not exceed 1/4".

7. Measure isolator deflection.

8. Verify snubber minimum clearances and that it does not exceed 1/4".

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping 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, but must not be more than 1/4" away from their point of restraint.

3.7 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in "Cast-in-Place Concrete" Section**.**

END OF SECTION 230548

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. Pipe labels.
4. Duct Labels.
5. Valve tags.
6. Warning tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

C. Samples: For color, letter style, and graphic representation required for each identification material and device.

D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

E. Valve numbering scheme. See paragraph 2.7.B.

F. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

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 ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers:

1. Craftmark Identification Systems
2. Seton Identification Products
3. MSI Marking Services
4. Setmark

2.2 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass or anodized aluminum, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and substrate.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Three-layer, multicolor, plastic labels for mechanical engraving, 1/16-inch-thick and having predrilled holes for attachment hardware.
2. Color Coding:

   a. Letter Color: White.
   b. Background Color: Red.

3. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.

B. Color Coding:

1. Background Color: Yellow.
2. Letter Color: Black.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless-steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PIPE LABELS

A. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.

B. General Requirements for Manufactured Pipe Labels: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger pipe sizes may have maximum sheet size with separate fastener.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing. Either marker shall show accepted color-coded background, proper color of legend in relation to background color, accepted legend letter size, accepted marker length.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.5 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Supply-air: Blue; Return-air: Green; Exhaust-air: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.6 VALVE TAGS

A. Valve Tags: Stamped or engraved with ¼-inch letters for piping system abbreviation and ½ inch sequenced numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2 by 11 inch 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. Valve tag schedule shall be included in operation and maintenance data.

2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as “DANGER”, “CAUTION” or “DO NOT OPERATE.”
4. Color:

a. Background Color: Yellow.
b. Letter Color: Black.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surface of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION 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.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Retain "Piping Color Coding" Paragraph below to identify piping systems by color-coded painting. Labels will still be required to identify service, pipe size, and flow direction.

B. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."

C. Revise "Pipe Label Locations" Paragraph below to suit Project.

D. 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 and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable ceilings. Omit intermediately spaced labels.

E. Directional Flow Arrows" Paragraph below is in compliance with ASME A13.1.

F. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

G. Pipe Label Color Schedule:

H. Retain first option in the following three subparagraphs below if water does not contain toxic or corrosive fluids per ASME A13.1.

1. Heating Water Piping: Black letters on a safety-orange background.

I. Retain first option in "Refrigerant Piping" Subparagraph below if refrigerant fluid is toxic or corrosive. All other options listed are user-defined options per ASME A13.1.

1. Refrigerant Piping: White letters on a red background.

J. Retain, in subparagraphs below, one of the user-defined color schemes per ASME A13.1.

3.5 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Supply-air duct: White letters on blue background.
2. Return-air duct: Whitte letters on green background.
3. Exhaustt-air duct: Black letters on yellow background.

3.6 VALVE-TAG INSTALLATION

A. Revise this article as required to delete an entire piping system from tagging or other changes. A schedule is helpful for complex projects. Retain and revise first paragraph below if a schedule is prepared.

B. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, 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.

C. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

D. Other valve-tag sizes and shapes may be available if required.

1. Valve-Tag Size and Shape:

a. Hot Water: 2 inches, round.

E. Tag colors, if used, should follow the color schemes defined by ASME A13.1.

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

   a. Constant-volume air systems.
   b. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:

   a. Constant-flow hydronic systems.

3. Testing, Adjusting, and Balancing Equipment:

   a. Heat exchangers.
   b. Motors.
   c. Heat-transfer coils.

4. Testing, adjusting, and balancing existing systems and equipment.
5. Duct leakage tests.
6. Control system verification.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.3 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site with the Engineer and Commissioning Agent 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.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: 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: Submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: 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.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Engage an independent TAB Contractor 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. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3- "System Balancing."

E. Provide statement that the TAB has not had any disciplinary action nor been on probation in the past five years.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, engage one of the following:

1. American Air Balance.
2. Air Balance Co., Inc.
3. Los Angeles Air Balance.

3.2 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, gage 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 used return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

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.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of 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. 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.

3.3 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.
    a. Duct systems are complete with terminals installed.
    b. Volume, smoke, and fire dampers are open and functional.
    c. Clean filters are installed.
    d. Fans are operating, free of vibration, and rotating in correct direction.
    e. Variable-frequency controllers' startup is complete and safeties are verified.
    f. Automatic temperature-control systems are operational.
    g. Ceilings are installed.
    h. Windows and doors are installed.
    i. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

    a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
    a. Piping is complete with terminals installed.
    b. Water treatment is complete.
    c. Systems are flushed, filled, and air purged.
    d. Strainers are pulled and cleaned.
    e. Control valves are functioning per the sequence of operation.
    f. Shutoff and balance valves have been verified to be 100 percent open.
    g. Pumps are started and proper rotation is verified.
    h. Pump gage connections are installed directly at pump inlet and outlet flanges or in

discharge and suction pipe prior to valves or strainers.

i. Variable-frequency controllers' startup is complete and safeties are verified.

j. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE Standard 111 or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping 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.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" 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.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

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 Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

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 Record Documents 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 Architect 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.
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, rpms, 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 at least two-thirds of the distance down the duct from the fan discharge or as shown on the Drawings.
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.
    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 Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

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 the same as described for constant-volume air systems.
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, rpms, volts, amps, and static profile.
d. Mark final settings.
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.
g. Verify building pressurization control by measuring building pressure at various operating conditions.

3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check liquid level in expansion tank.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

3.9 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.

1. Measure total water flow.

a. Position valves for full flow through coils.
b. Measure flow by main flow meter, if installed.

c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

2. 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 gage 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.
e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

D. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or by using P/T ports.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

G. Verify that memory stops have been set.

3.10 PROCEDURES FOR MOTORS

A. Motors 1/2 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.

3.11 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

3.12 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.13 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature 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.

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.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.

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 systems balancing devices. Recommend changes and additions to systems 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 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.

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.
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 and pump 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. Fan drive settings including settings and percentage of maximum pitch diameter.
    e. Settings for supply-air, static-pressure controller.
    f. 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 with coils, 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, and bore.
    i. Center-to-center dimensions of sheave and number of adjustments in inches.
    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 rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave and number of adjustments in inches.

3. Test Data (Indicated and Actual Values):

   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat-coil static-pressure differential in inches wg.
   g. Cooling-coil static-pressure differential in inches wg.
   h. Heating-coil static-pressure differential in inches wg.
   i. Outdoor airflow in cfm.
   j. Return airflow in cfm.
   k. Outdoor-air damper position.
   l. 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 o.c.
   f. Make and model number.
   g. Face area in sq. ft.
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

   a. Airflow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
   e. Return-air, wet- and dry-bulb temperatures in deg F.
   f. Entering-air, wet- and dry-bulb temperatures in deg F.
   g. Leaving-air, wet- and dry-bulb temperatures in deg F.
   h. Water flow rate in gpm.
   i. Water pressure differential in feet of head or psig.
   j. Entering-water temperature in deg F.
   k. Leaving-water temperature in deg F.
   l. Refrigerant expansion valve and refrigerant types.
   m. Refrigerant suction pressure in psig.
   n. Refrigerant suction temperature in deg F.

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, and bore.
   h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Suction static pressure in inches wg.

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 and air-handling-unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

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.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

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.

b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

K. 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 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 testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, 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.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, Owner may contact AABC Headquarters regarding the Performance Guaranty.

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 SUMMARY

A. This Section includes mechanical insulation for duct, equipment, and pipe, including the following:

1. Insulation Materials:

a. Mineral-Fiber blanket.

2. Adhesives.
3. Tapes.
4. Securements.
5. Corner angles.

B. Related Sections include the following:

1. Division 23 Section "Metal Ducts" for duct liners.

1.2 DEFINITIONS

A. FSK: Foil, scrim, kraft paper.

B. FSP: Foil, scrim, polyethylene.

C. SSL: Self-sealing lap.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings: Show details for the following:

1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
3. Removable insulation at piping specialties, equipment connections, and access panels.
4. Application of field-applied jackets.
5. Application at linkages of control devices.
6. Field application for each equipment type.

C. Installer Certificates: Signed by Contractor certifying that installers comply with requirements.

D. 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.

1.4 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. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting 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.

1.5 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.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:

a. Johns Manville; Microlite.
b. Knauf Insulation; Duct Wrap.
c. Owens Corning; All-Service Duct Wrap.
d. Certainteed Corp.; Soft Touch Duct Wrap.

F. Noise Barrier wrap: Fire-Resistant, mass-loaded, limp vinyl with a layer of reinforced aluminum foil facing on one side.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Kinetics Noise Control, Inc. (Model KNM-100AL)

2. Sound Transmission Loss when tested as a free hanging barrier shall be:

Frequency, Hz	63	125	250	500	1000	2000	4000
KNM-100AL	-	13	17	21	28	33	40

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. Products:

    a. Aeroflex USA Inc.; Aeroseal.
    b. Armacell LCC; 520 Adhesive.
    c. Foster Products Corporation, H. B. Fuller Company; 85-75.
    d. RBX Corporation; Rubatex Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products:

    a. Childers Products, Division of ITW; CP-82.
    b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    d. Marathon Industries, Inc.; 225.
    e. Mon-Eco Industries, Inc.; 22-25.

2.4 TAPES

A. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.

1. Products:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    b. Compac Corp.; 120.
    c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
    d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.5 SECUREMENTS

A. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.

    a. Products:

        1) AGM Industries, Inc.; CWP-1.
        2) GEMCO; CD.
        3) Midwest Fasteners, Inc.; CD.
        4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

a. Products:

1) AGM Industries, Inc.; CWP-1.
2) GEMCO; Cupped Head Weld Pin.
3) Midwest Fasteners, Inc.; Cupped Head.
4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products:

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Available Products:

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, galvanized steel.

1. Manufacturers:

a. ACS Industries, Inc.
b. C & F Wire.
c. Childers Products.
d. PABCO Metals Corporation.
e. RPR Products, Inc.

2.6 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040-inch-thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. 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 COMMON INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and 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.

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 application and finishing.

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 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.
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- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. 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 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

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 beyond damaged areas. Adhere, staple, and seal patches similar 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. Handholes.
5. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetra-

tions.

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 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.
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: Install insulation continuously through penetrations of fire-rated walls and partitions. 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.

1. Firestopping and fire-resistive joint sealers are specified in Division 07 Section "Through-Penetration Firestopping."

3.5 MINERAL-FIBER INSULATION INSTALLATION

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 and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches 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 ple-

nums.

d. Do not over compress 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 1 edge and 1 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 2 times the insulation thickness but not less than 3 inches (75 mm).

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches 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- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 NOISE BARRIER LAGGING INSTALLATION

A. Where noise barrier wrap is indicated (indicated as shaded on supply ducts), wrap insulated supply ducts with noise barrier in strict accordance with manufacturer's printed installation instructions.

B. Noise barrier shall be overlapped a minimum of 2 inches on all seams and sealed with acrylic adhesive according to manufacturer's installation instructions.

C. Metal bands shall be used at 18 inch o.c. spacing to secure barrier in place. Banding shall not compress the underlying fiberglass duct wrap. Use of adhesive tape to hold noise lagging in place is prohibited. Alternatively, pins and washers can be used to impale the lagging in place, as described for mineral-fiber duct wrap installation.

3.7 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

   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. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Supply and return air ducts.

a. Concealed supply and return ducts.
b. Supply and return ducts that are within an attic return plenum and above a ceiling.

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.
8. Exposed-to-view ducts within conditioned space they serve, unless otherwise indicated on plans.
9. Exhaust ducts.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Exposed supply, return, outside air and relief ducts located in mechanical rooms:

1. 2-inch-thick duct liner-see Metal Ducts Section.

B. Concealed supply and return air ducts:

1. Mineral-Fiber Blanket: 3 inches thick and 0.75-lb/cu. ft. nominal density. Minimum installed R-Valve of 8.0.

3.10 ABOVEGROUND, SUPPLY AND RETURN DUCT AND PLENUM INSULATION SCHEDULE

A. Duct liner- see specification section 233113 Metal Ducts.

END OF SECTION 23 07 13

SECTION 23 07 16

HVAC EQUIPMENT 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 HVAC equipment that is not factory insulated:

1. Heating-hot water pumps.
2. Expansion tanks.
3. Air separators.
4. Buffer tanks.

B. Related Sections:

1. Division 23 "Duct Insulation."
2. Division 23 "HVAC Piping Insulation."

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. 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 removable insulation at equipment connections.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.
5. Detail field application for each equipment type.

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 E 84, 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.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

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 "Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds or PBDE's (Polybrominated Dipenyl Ethers).

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 C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CertaPro Commercial Board.
b. Johns Manville; 800 Series Spin-Glas.
c. Knauf Insulation; Insulation Board.
d. Owens Corning; Fiberglas 700 Series.

G. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Owens Corning; Fiberglas Pipe and Tank Insulation.

H. Flexible Elastomeric Insulation: Closed-cell, sponge or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. K-Flex USA.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ramco Insulation, Inc.; Thermokote V.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive 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."

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. Foster Brand; H. B. Fuller Construction Products.
d. K-Flex USA.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive 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."

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, viable products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive 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."

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants 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."

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants 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."

2.6 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: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering equipment.

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for equipment.

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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
   b. Vimasco Corporation; Elastafab 894.

2.8 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..

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. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, 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 Outdoor Applications: 2.5-mil- thick polysurlyn.
d. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

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. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.

c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

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. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.11 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
3. 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. 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.

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

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) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

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. C & F Wire.

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 and equipment 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.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. 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 equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment 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.

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. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

J. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

N. 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. Handholes.
5. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not over compress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. 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.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings and stretch prestressed aircraft cable radially from the

wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.5 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 overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where metal jackets are indicated, install with 2-inch 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 o.c. and at end joints.

C. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer’s recommended protective coating.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections: Inspect field-insulated equipment, 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 type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heating-hot-water pump insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

D. Heating-hot-water expansion/compression tank insulation shall be one of the following:

1. Mineral-Fiber Board: 1 inch thick and 6-lb/cu. ft. nominal density.
2. Mineral-Fiber Pipe and Tank: 1 inch thick.

E. Heating-hot-water air-separator insulation shall be one of the following:

1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.
2. Mineral-Fiber Pipe and Tank: 2 inches thick.

3.8 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. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Stucco Embossed: 0.020 inch thick.

D. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Aluminum, Smooth Stucco Embossed with 1-1/4-Inch- Deep Corrugations: 0.032 inch thick.

3.9 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. Equipment, exposed, less than 24 inches in diameter:

1. Aluminum, Stucco Embossed: 0.016 inch thick.

D. Equipment, Exposed, 24 to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.032 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Aluminum, Stucco Embossed with 1-1/4-Inch- Deep Corrugations: 0.032 inch thick.

END OF SECTION 23 07 16

SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Heating Hot Water piping, indoors and outdoors.

1.2 ACTION SUBMITTALS

A. 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 pipe expansion joints for each type of insulation.
3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4. Detail removable insulation at piping specialties.

B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied), if any.

1.3 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 E 84, by a testing and inspecting 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.

1.4 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.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC 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.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

2.2 GLASS FIBER

A. Manufacturers: Owens-Corning Fiberglass 25 ASJ/SSL, Johns Manville Micro-Lok, Certainteed, Knauf or equal.

B. Type I, 850 deg F Materials; Mineral or glass fibers bonded with thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ-SSL jacket. Factory applied jacket requirements are specified in “Factory Applied Jackets” Article.

2.3 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.4 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, 1/2-inch 3/4-inch-wide with closed seal.

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. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide product by:

a. C & F Wire.

2.5 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket: Aluminum jacket shall comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules. Moisture Barrier for Outdoor Applications:3-mil thick, heat bonded polyethylene and kraft barrier.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

   a. Preformed 2-piece or gore, 45- and 90- degree, short- and long-radius elbows.
   b. Tee covers.
   c. Flange and union covers.
   d. End caps.
   e. Beveled collars.
   f. Valve covers.

C. Flexible Elastomeric Insulation: Closed-cell, sponge or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

   1. Products: Subject to compliance with requirements, provide one of the following:

      a. Aeroflex USA, Inc.; Areocel.
      b. Armacell LLC, AP Armaflex.
      c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.2 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 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.

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 application and finishing.

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 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.
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- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. 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 2 inches 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 pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

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 beyond damaged areas. Adhere, staple, and seal patches similar 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. Handholes.
5. Cleanouts.

3.3 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 below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. 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 Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.4 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, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, 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 adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill 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 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 used for adjacent pipe. Overlap adjoining pipe insulation by not less than two 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 two 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 and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the

mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted Aluminum cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with Aluminum end caps. Tape Aluminum covers to adjoining insulation facing using PVC tape.
9. Label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

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 adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two 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.
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 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.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturers 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 pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers 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 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.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where metal jackets are indicated, install with 2-inch 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 o.c. and at end joints.

3.7 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating it exposed to sunlight (i.e. UV radiation).

B. Do not field paint aluminum or stainless-steel jackets.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. 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 Work if sample inspection reveals noncompliance with requirements.

3.9 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.

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.

3.10 PIPING INSULATION SCHEDULE

A. Heating Hot Water Piping: Glass fiber, 1-1/2 inch thick.

3.11 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. Piping, Concealed:

1. None.

C. Piping, Exposed:

1. Aluminum Stucco Embossed: 0.024 inch thick.

3.12 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. Piping, Concealed:

1. None.

C. Piping, Exposed:

1. Aluminum, Stucco Embossed, 0.024 inch thick.

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SECTION 23 09 00

BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish a totally native BACnet-based Building Automation System (BAS), including the most current versions of Windows 10 Professional, Windows Server or SQL Server with compatible operator's workstation and server. The operator's workstation and server, all building controllers, controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2012, BACnet. In other words, all workstations and servers, and controllers, including unitary controllers, shall be native BACnet devices.

B. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

C. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

D. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

E. Design, provide, and install all equipment cabinets, panels, conduit as required, data communication network cables needed, and all associated hardware.

F. Provide and install all interconnecting cables between supplied cabinets, controllers, and input/output devices.

G. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.

H. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

I. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

J. Provide a comprehensive operator and technician training program as described herein.

K. Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

L. Provide new sensors, dampers, valves, and install only new components. No used components shall be used as any part or piece of installed system.

1.2 SYSTEM DESCRIPTION

A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-2012, BACnet and achieved listing under the BACnet Testing Laboratories BACnet - Advanced Workstation Software (B-AWS). This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, heat pumps, fan-coils, AC units, etc., and all air handlers, boilers, chillers, and any other listed equipment using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

B. Operator's workstation and server software shall use the most current versions of Windows 10 Professional, Windows Server or SQL Server as the computer operating system. The Building Automation System (BAS) program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, and a full suite of field engineering tools including graphical programming and applications.

C. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

D. Room sensors shall be provided with digital readout that allow the user to view room temperature, humidity or CO2 as required, view outside air temperature, adjust the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow a technician to balance VAV zones and access any parameter in zone controller directly from the room sensor. Field service mode shall have the ability to be locked out.

E. All controllers for every terminal unit (VAV, HP, etc.) air handler, all central plant equipment, and any other piece of controlled equipment shall be fully programmable. Controllers shall be mounted next to controlled equipment and communicate with building controller through the BACnet LAN.

F. All control logic to satisfy the Sequence of Operation must reside in standalone programmable controllers, except for non-critical global supervisory functions such as optimized scheduling or setpoint offsets.

1.3 APPROVED MANUFACTURERS AND INSTALLERS

A. Approved Control Manufacturers

1. Honeywell by Allison Mechanical

1.4 QUALITY ASSURANCE

A. The BAS shall be designed, installed, commissioned, and serviced by manufacturer authorized and trained personnel. System provider shall have an in-place support facility within 2 hours

response time of the site with technical staff, spare parts inventory, and necessary test and diagnostic equipment.

1. The Bidder shall be regularly engaged in the design, installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the design, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.

B. Materials and equipment shall be manufacturer's latest standard design that complies with the specification requirements.

C. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

D. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference, and be so labeled.

E. Control system shall be engineered, programmed and supported completely by representative's local office that must be within 100 miles of project site.

1.5 REFERENCE STANDARDS

A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
2. ANSI/ASHRAE Standard 135-2012, BACnet.
3. Uniform Building Code (UBC), including local amendments.
4. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
5. National Electrical Code (NEC).
6. FCC Part 15, Subpart J, Class A.
7. EMC Directive 89/336/EEC (European CE Mark).
8. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences.
9. Title 24, Part 6: 2023 California Building Energy Efficiency Standards.

B. City, county, state, and federal regulations and codes in effect as of contract date.

C. Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections, and certifications required for his work, and arrange for necessary approvals by the governing authorities.

1.6 SUBMITTALS

A. Drawings

1. The system supplier shall provide a fully complete submittal including point to point engineered drawings, control sequences of operations, bill of materials, and cut sheets for all control devices for approval. Incomplete submittals will be rejected. Partial submittals are not acceptable.

2. Provide drawings in PDF format.

B. System Documentation

1. Include the following in submittal package:

a. System architecture drawing.
b. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
c. Complete bill of materials, valve schedule and damper schedule. Valve schedules shall include corrected actual valve pressure drops per selected Cv at full flow.
d. Cut sheets of all control devices.
e. For all system elements—operator's workstation **and server,** building controller(s), controllers, routers, and repeaters—provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2012.
f. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.

C. Project Management

1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents, and shall indicate timing and dates for system installation, debugging, and commissioning.

1.7 WARRANTY

A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one (1) year from completion of system acceptance. Control devices that fail during the warranty period shall be adjusted, repaired or replaced at no additional cost to the owner.

B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours, Monday through Friday, and 48 hours on Saturday and Sunday.

C. This warranty shall apply equally to both hardware and software.

1.8 RELATED WORK IN OTHER SECTIONS

A. Refer to Division 0 and Division 1 for related contractual requirements.

B. 230593 Testing, Adjusting, and Balancing for HVAC

C. 120800 Commissioning of HVAC

D. 237413 Package, Outdoor, Central Station Air Handling Units

E. 238126 Split System Air Conditioners

F. 238219 Fan Coil Units

G. 260000 General Electrical Provisions.

H. 260519 Low Voltage Electrical Power Conductors and Cables

I. 260523 Control Voltage Electrical Power Cables

J. 260529 Hangers and Supports for Electrical Systems

K. 260533 Raceways and Boxes for Electrical Systems

1.9 PRODUCTS INTEGRATED TO BUT NOT FURNISHED OR INSTALLED UNDER THIS SECTION

A. 236423 Air Source Heat Pumps

B. 237400 Packaged Rooftop Outdoor HVAC Equipment

PART 2 - PRODUCTS

2.1 OPERATOR'S WORKSTATION [SERVER AND OPERATING SOFTWARE]

A. The Operator's Workstation and server are existing on site. The scope of work for this project is to expand the existing system.

B. General structure of workstation and server interaction shall be a standard client/server relationship. Server shall be used to archive data and store system data. Clients shall access server for all archived data. Each client shall include flexibility to access graphics from server or local drive. Server shall support a minimum of 50 simultaneous clients.

1. A customized menu label (pushbutton) shall be used for display selection. Menu items on a display shall allow penetration to lower-level displays or additional menus. Dynamic point information and menu label pushbuttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A security level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.
2. The BAS displays shall have the ability to link to content outside of the BAS system. Such content shall include but is not limited to: Launching external files in their native applications (for example, a Microsoft Word document) and launching a web browser resolving to a specified web address.
3. The BAS system shall have the ability to run multiple, concurrent displays windows showing continuously updated data.

C. Password Protection

1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.
2. Each operator's terminal shall provide security for a minimum of 200 users. Each user shall have an individual User ID, User Name, and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be 0–8 characters, User Name shall be 0–29 characters, and Password shall be 4–8 characters long. System shall include an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period

shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.

3. The system shall permit the assignment of an effective date range, as well as an effective time of day, that the User IDs are permitted to authenticate.

D. Operator Activity Log

1. Operator Activity Log that tracks all operator changes and activities shall be included with system. System shall track what is changed in the system, who performed this change, date and time of system activity, and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation. Operator shall be able to print the Operator Activity log display.
2. Log shall be gathered and archived to the server hard drive on operator's workstation as needed. Operator shall be able to export data for display and sorting in a spreadsheet.

E. Scheduling

1. The graphical user interface shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for the day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.
2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.
3. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.
4. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.

F. Alarm Indication and Handling.

1. The BAS shall provide audible, visual, printed, and email means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s) currently running. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID's authorization level.
2. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.
3. Alarm messages shall be in user-definable text (English or other specified language) and shall be delivered either to the operator's terminal, client or through remote communication using email (Authenticated SMTP supported).

G. Trendlog Information

1. System server shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. System

database shall be capable of storing up to 50 million records before needing to archive data. Samples may be viewed at the graphic user interface. Operator shall be able to view all trended records, both stored and archived. All trendlog records shall be displayed in standard engineering units.

2. Software that is capable of graphing the trend logged object data shall be included. Software shall be capable of creating two-axis (X, Y) graphs that display up to 10 object types at the same time in different colors. Graphs shall show object values relative to time. Each trendlog shall support a custom scale setting for the graph view that is to be stored continuously. System shall be capable of trending on an interval determined by a polling rate, or change-of-value.
3. Operator shall be able to change trendlog setup information. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.
4. System shall be capable of using Microsoft SQL as the system database.

H. Energy Log Information

1. System server shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.
2. All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.
3. Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.
4. System shall display archived data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

I. Demand Response

1. For T-24 compliance, the system shall include demand response program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system. Binary shedding shall include minimum of five (5) priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one, the loads shall be shed/restored in a “first off-first on” mode, and in the other the loads are just shed/restored in a “first off-last on” (linear) fashion.
2. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.
3. Status of each and every load shed program shall be capable of being displayed on every operator terminal connected to system. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.
4. Load shedding shall only be implemented at the direction of the Owner upon the Owner’s coordination with the local Utility Company.

J. Reports

1. System server shall be capable of periodically producing reports of trend logs, alarm history, tenant activities, device summary, energy logs and override points. The frequency, content and delivery are to be user adjustable.
2. All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed or saved to a folder, either on the server hard drive or on any network drive location.

K. Configuration/Setup: Provide means for operator to display and change system configuration. This shall include, but not be limited to, system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.

L. Field Engineering Tools

1. The BAS software shall include field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.
2. User shall be able to select a graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
3. Programming tools shall include a real-time operation mode. Function blocks shall display real-time data and be animated to show status of data inputs and outputs when in real-time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.
4. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of BAS software.
5. System shall automatically notify the user when a device that is not in the database is added to the network.
6. System shall include backup/restore function that will back up entire system to selected medium and then restore system from that media. The system shall be capable of creating a backup for the purpose of instantiating a new client PC.
7. The system shall provide a means to scan, detect, interrogate, and edit third-party BACnet devices and BACnet objects within those devices.

M. Server Hardware

1. The server is existing and shall be expanded for this project.
2. Provide server at location noted on the plans.
3. Workstation and server minimum requirements: The workstation and rack-mounted desk top server shall consist of a high-speed central processing unit (CPU) with data storage facilities. Components shall be capable of operating in environments of 60°F to 105°F and relative humidity of 30% to 90%.

    a. The CPU in shall be a 13th generation or higher Intel Core i7 processor.
    b. Memory: 8 GB (minimum)
    c. Hard Drive: 500GB (minimum) for the BAS operating software
    d. Hard Drive: 1 TB (minimum) to be used for trend log archiving.
    e. Display: Video card capable of displaying 1920 x 1080 pixel resolution or greater.

f. Network Support: Ethernet adapter (10/100/1000 Mb with RJ-45 connector, or greater).
g. Graphical user interface shall be via web browser interface.

N. Software

1. At the conclusion of project, BAS contractor shall leave with owner a DVD ROM that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner to completely restore the system in the case of a computer malfunction.

2.2 WEB BROWSER INTERFACE

A. General: BAS supplier shall provide web-based access to the system as part of standard installation. User must be able to access all displays of real-time data that are part of the BAS using a standard web browser. Web browser shall tie into the network through owner-supplied Ethernet network connection. The webpage software shall not require a per-user licensing fee or annual fees. The web browser must be able to support on average 50 simultaneous users with the ability to expand the system to accommodate an unlimited number of users.

B. Browser Technology: Browser shall be the most current version of Internet Explorer, Firefox, Safari (on Mac OS X). WEB browsers: Internet Explorer, Firefox, Google Chrome, Safari on Mac. WEB mobile client support: Microsoft Mobile WAP browser, or HTML. No special vendor-supplied software shall be needed on computers running browser. All displays shall be viewable and the web browser shall directly access real-time data from the BAS BACnet network. Data shall be displayed in real-time and update automatically without user interaction. User shall be able to change data on displays if logged in with the appropriate user name and password.

C. Communications

1. BAS BACnet Ethernet network shall be provided and installed by the BAS supplier. Owner shall provide and incur any monthly charges of WAN/Internet connection.

D. Display of Data

1. Webpage graphics shown on browser shall be replicas of the BAS displays. User shall need no additional training to understand information presented on webpages when compared to what is shown on BAS displays. Webpage displays shall include animation just as BAS displays. Fans shall turn, pilot lights shall blink, coils shall change colors, and so on.
2. Real-time data shall be shown on all browser webpages. This data must be directly gathered using the BACnet network and automatically updated on browser webpage displays without any user action. Data on the browser shall automatically refresh as changes are detected without re-drawing the complete display.
3. It shall be possible for user from browser webpage to change data if the user is logged on with the appropriate password. Clicking on a button or typing in a new value shall change digital data. Using pull-down menus or typing in a new value shall change analog data.
4. Data displays shall be navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display. Alternatively, the standard back and forward buttons of the browser can be used for display navigation.

E. Time Schedule Adjustment

1. Web access shall allow user to view and edit all schedules in the system. This includes standard, holiday and event schedules as described in BAS specification. Display of schedules shall show interaction of all schedules on a single display so user sees an overview of how all work together. User shall be able to edit schedules from this display. Display of all three schedules must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.
2. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.

F. Logging of Information: User shall use standard browser technology to view all trendlogs in system. User shall be able to view logged data in tabular form or graphical format. User shall be able to adjust time interval of logged data viewed and shall be able to adjust Y axis of data viewed in graphical format. User shall also be able to download data through the web browser to local computer. Data shall be in CSV format.

G. Alarm Handling: Web browser shall display alarms as they occur. User shall be able to acknowledge alarms using browser technology. In addition, user shall be able to view history of alarm occurrence over a user-selected time frame. In addition, those alarms may be filtered for viewing per user-selected options. A single selection shall display all alarms that have not been acknowledged.

H. Webpage Generation: Webpages shall be automatically generated from the BAS displays that reside on the BAS server. User shall access webpage host through the network and shall initiate a webpage generation utility that automatically takes the BAS displays and turns them into webpages. The webpages generated are automatically installed on the webpage host for access using any computer's standard browser.

I. Password Security and Activity Log: Access through web browser shall utilize the same hierarchical security scheme as BAS system. User shall be asked to log on once the browser makes connection to webpage host. Once the user logs in, any and all changes that are made shall be tracked by the BAS system. The user shall be able to change only those items he or she has authority to change. A user activity report shall show any and all activity of the users who have logged in to the system, regardless of whether those changes were made using a browser or through the BAS workstation.

J. BACnet Communication: Web browser shall directly communicate to all devices on the BAS network using BACnet protocol. No intermediate devices shall be necessary for BACnet communication.

2.3 BUILDING NETWORK CONTROLLER

A. General Requirements

1. Building controller shall be of modular construction such that various modules may be selected to fit the specific requirements of a given project. At a minimum, modules shall consist of a power supply module, a BACnet Ethernet-MS/TP (master slave token passing) module, a BACnet MS/TP-only module, and a modem module for telephone communication. Those projects that require special interfaces may use Modbus modules as needed. However, all Ethernet communications and all controllers—including central

plant controllers, expandable central plant controllers, VAV box controllers and unitary terminal unit controllers—supplied by BAS manufacturer shall utilize the BACnet protocol standard.

2. Modules shall be selected to fit the particular project application. Up to seven (7) modules shall be powered by a single power supply module. All modules shall be panel-mounted on DIN rail for ease of addition and shall be interconnected using a simple plug-in cable. A module in the middle shall be replaceable without removing any other modules.
3. All modules shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller. The software program implementing these strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, using a WAN or downloaded through remote communications are not acceptable. Changing global strategies using firmware changes is also unacceptable.
4. Programming shall be object-oriented using control function blocks, and support DDC functions, 1000 Analog Values and 1000 Binary Values. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation and server. The same tool shall be used for all controllers.
5. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing.
6. Controller shall have sufficient memory to ensure high performance and data reliability. Battery shall provide power for orderly shutdown of controller and storage of data in nonvolatile flash memory. Battery backup shall maintain real-time clock functions for a minimum of 20 days.
7. Global control algorithms and automated control functions shall execute using 32-bit processor.
8. Schedules

    a. Each building controller module shall support a minimum of 80 BACnet Schedule Objects and 80 BACnet Calendar Objects.
    b. Building controller modules shall provide normal 7-day scheduling, holiday scheduling and event scheduling.
    c. Logging Capabilities
    d. Each building controller shall log as minimum 320 values. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the graphical user interface.
    e. Logs may be viewed both on-site or off-site using WAN or remote communication.
    f. Building controller shall periodically upload trended data to networked operator's workstation and server for long-term archiving if desired.
    g. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

9. Alarm Generation

    a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
    b. Each alarm may be dialed out as noted elsewhere.
    c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
    d. Controller must be able to handle up to 320 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

10. Demand Limiting

a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 200 loads using a minimum of two types of shed programs.
b. Load shedding programs in building controller modules shall operate as defined in section 2.1 of this specification.

11. Tenant Activity Logging

a. Tenant Activity logging shall be supported by building controller module. Each independent module shall support a minimum of 80 zones.
b. Tenant Activity logging shall function as defined in section 2.1 of this specification.

B. Ethernet – MS/TP Module

1. Ethernet – MS/TP Module shall support every function as listed under section 1.1of this section and the following.
2. As noted on the drawings, communication with operator's workstation **and server** and all controllers shall be through BACnet. Building controller Ethernet – MS/TP module shall incorporate as a minimum, the functions of a 2-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz) and MS/TP LAN. Ethernet – MS/TP module shall also route messages from all other building controller modules onto the BACnet Ethernet network.

a. MS/TP LAN must be software-configurable from 9.6 to 76.8Kbps.
b. The RJ-45 Ethernet connection must accept either 10base-T or 100base-TX BACnet over twisted pair cable (UTP).

C. MS/TP Module

1. MS/TP module shall support every function as listed under section 1.1.
2. Building controller MS/TP module communications shall be through BACnet MS/TP LAN to all controllers. MS/TP module shall also route messages to Ethernet – MS/TP module for communication over WAN.

a. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps
b. Configuration shall be through RS-232 connection.

D. Power Supply Module

1. Power supply module shall power up to seven (7) building controller modules. Input for power shall accept between 17–30VAC, 47–65Hz.
2. Power supply module shall include rechargeable battery for orderly shutdown of controller modules including storage of all data in flash memory and for continuous operation of real-time clocks for minimum of 20 days.

E. Modbus Module

1. Modbus Module shall support every function as listed under section 1.1.
2. Building Controller Modbus module communications shall be via one of three types of ports: EIA-485, EIA-422 or RS-232 connection. Modbus module shall convert Modbus data into BACnet objects. Modbus module shall also route messages to Ethernet-MS/TP module for BACnet Ethernet communication over WAN.

a. Modbus Module shall support ASCII or RTU Modbus communication at 9600 or 4800 baud.

b. EIA-422 and EIA-232 connection shall support one connection of Modbus unit.
c. EIA-485 connection shall support connection of up to 247 Modbus units.
d. Configuration shall be via RS-232 connection.

3. BACnet Translation

a. All Modbus data shall be translated into BACnet objects by the Modbus module. All configuration tools shall be supplied to assure data is translated as necessary to the correct format and value.
b. Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

2.4 TERMINAL UNIT BACnet/IP CONTROLLERS (Fan-Coils)

A. Provide one (1) native BACnet controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building network controller through BACnet/IP protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

B. Controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of three (3) pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

C. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Controller shall be programmed using same programming tools as building controller and as described in operator workstation server and operating software section. All programming tools shall be provided and installed as part of system.

D. Controller shall include support for intelligent room sensor. Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

2.5 VAV BOX BACnet/IP CONTROLLERS—SINGLE DUCT

A. Provide one (1) native BACnet controller for each VAV box that adequately covers all objects listed in object list for unit. All controllers shall interface to building network controller through BACnet/IP protocol. No gateways shall be used. Controllers shall include on board CFM flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

B. Controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, and dry contact signals. Inputs on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall also include binary outputs on board. For applications using variable speed parallel fans, provide a single analog output selectable for 0–10 V or 0–20 mA control signals. Controller shall include microprocessor driven flow sensor for use in pressure independent control logic. All boxes shall be controlled using pressure-independent control algorithms and all flow readings shall be in CFM (LPS if metric).

C. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Controller shall be programmed using the same programming tool as Building Controller and as described in operator's workstation and server and operating software section. All programming tools shall be provided as part of system.

D. Controller shall include support for intelligent room sensor. Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operations for specific display requirements for intelligent room sensor.

E. On-board flow sensor shall be microprocessor-driven and pre-calibrated at the factory. Pre-calibration shall be at 16 flow points as a minimum. All factory calibration data shall be stored in non-volatile memory. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Portable computers, and special hand-held field tools shall not be needed for field calibration.

F. Provide duct temperature sensor at discharge of each VAV box equipped with a reheat coil.

2.6 AUXILIARY CONTROL DEVICES

A. Intelligent Room Sensor with LCD Readout

1. Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit and allow occupant to raise and lower setpoint, and activate terminal unit for override use—all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.
2. The intelligent room sensor shall simultaneously display room setpoint, room temperature, outside temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. The site developer should be able to program the unit to display time-of-day, room humidity and outdoor humidity. Unit must have the capability to show temperatures in degrees Fahrenheit or Centigrade.
3. Override time may be set and viewed in half-hour increments. Override time countdown shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word "OFF" in unoccupied mode unless a function button is pressed.

4. See sequence of operation for specific operation of LCD displays and function keys in field service mode and in normal occupant mode. Provide intelligent room sensors as specified in point list.
5. Field service mode shall be customizable to fit different applications. If intelligent room sensor is connected to VAV controller, VAV box shall be balanced and all air flow parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

B. Temperature Sensors

1. Duct mount, indoor: Veris TF series 10K ohm, type II thermistor with stainless steel probe and junction box, or equal. Accuracy ±0.5ºC (±1ºF)
2. Duct mount, outdoor: Veris TF series 10K ohm, type II thermistor with stainless steel probe and weather-tight junction box, or equal. Accuracy ±0.5ºC (±1ºF)
3. Outside air: Veris TO series 10K ohm, type II thermistor with stainless steel probe encased in durable radiation shield with weather-tight junction box, or equal. Accuracy ±0.5ºC (±1ºF)
4. Pipe insertion: Veris TIG series 10K ohm, type II thermistor with corrosion resistant stainless steel probe, thermo well, and standard or weather-tight junction box as required, or equal. Accuracy ±0.5ºC (±1ºF)
5. Averaging: Veris TA series 10K ohm, type II thermistor encased in flexible copper tubing to enhance response time, or equal. Provide with standard or weather-tight junction box as required. Mounting of tubing shall utilize AA64 mounting clips. Accuracy ±0.5ºC (±1ºF)

C. Humidity Sensors Wall Mount: Veris HW series humidity, 2% accuracy thin film capacitive replaceable sensor element, LED display, or equal.

D. Humidity Sensors Outside air: Veris HO series humidity sensor, 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing, or equal.

E. Humidity Sensors Duct: Veris HD series humidity sensor, 2% accuracy thin film capacitive replaceable sensor element, with die cast metal housing, or equal.

F. Humidity Sensors Wall mount, with temperature: Veris HW series combination humidity and temperature sensor. Temperature accuracy ±0.5ºC (±1ºF), RH 2% accuracy. Thin film capacitive replaceable sensor element, LED display, push button override and setpoint slider, or equal.

G. Humidity Sensors Outside Air, with temperature: Veris HO series combination humidity and temperature sensor. Temperature accuracy ±0.5ºC (±1ºF), RH 2% accuracy. Thin film capacitive replaceable sensor element, with weatherproof housing, or equal.

H. Humidity Sensor Duct, with temperature: Veris HD series combination humidity and temperature sensor. Temperature accuracy ±0.5ºC (±1ºF), RH 2% accuracy. Thin film capacitive replaceable sensor element, with die cast metal housing, or equal.

I. Humidity High Limit Switch, Duct: Honeywell H6045A1002 duct mount hygrostat with insertion probe, adjustable trip dial, and NO and NC contacts, or equal.

J. CO2 Sensors

1. Room, wall mount: Veris CWE series with non-dispersive infrared sensor, repeatable to +/- 20 ppm, or equal.
2. Outdoor and Duct: Veris CDE series with non-dispersive infrared sensor, repeatable to +/- 20 ppm, or equal.

K. CO2, Humidity, Temperature Combined Sensor (Duct and Wall)

1. Veris C Series Deluxe Duct and Wall CO2 sensor with set point slider and LCD display, or equal.

   a. CO2 sensor with non-dispersive infrared sensor, repeatable to +/- 20 ppm.
   b. Humidity Sensor digitally profiled thin-film capacitive, plus or minus 2% RH.
   c. Temperature Sensor: Thermistor. Accuracy ±0.5ºC (±1ºF)

L. Leak Detector condensate pan overflow detection: Veris SD-R01 detector, 24V AC, with automatic reset, and 14 foot cable, or equal.

M. Differential Pressure Transmitter:

1. Duct Static Pressure Transmitter: Veris PX series differential pressure transducer with selectable range, +/- 1% accuracy, with push button auto-zero, LCD display, or equal.
2. Building Static Pressure Transmitter: Veris PX series differential pressure transducer with selectable range, +/- 1% accuracy, with push button auto-zero. Provide with AA05 ceiling mount static pressure pick up, LCD display, or equal.
3. Water differential pressure transmitter: Veris PW2 series differential pressure transmitter, wet/wet, switch selectable pressure ranges, jumper selectable port swap, LCD display and NEMA 4 enclosure, or equal.

N. Differential Pressure Switch:

1. Filter differential pressure switch for status: Dwyer Series ADPS adjustable differential pressure switch, dual scale adjustable knob, silicone diaphragm and NEMA 13 enclosure, or equal.
2. Duct static pressure hi-low pressure safety switch for fan shut down: Dwyer Series 1900MR with adjustable trip and manual reset, or equal.

O. Current Sensors

1. Current sensing switch for fans, pumps, etc.: Hawkeye Hx08 series current switch with split core, adjustable trip, pilot light, self-gripping split core housing and mounting bracket, or equal.
2. Current sensing switch for VFD's: Hawkeye H614 Automatic VFD current switch split core, self-learning adjustable trip, pilot light, self-gripping split core housing and mounting bracket, or equal.
3. Current sensing switch with relay for fan start: Hawkeye H 900 series current switch with split core, integral relay, adjustable trip, pilot light, self-gripping split core housing and mounting bracket, or equal.
4. Current sensing transmitter: Hawkeye H921 current sensing transmitter with self-gripping split core, preset slide switches, and removable mounting bracket, or equal.
5. Current sensing transmitter with relay for fan start: Hawkeye H931 current sensing transmitter with integral relay, slide switches, self-gripping split core, and removable mounting bracket, or equal.

P. Flow Meters Liquid:

1. Onicon F-1100 single turbine insertion flow meter, 316 stainless steel, weather tight aluminum enclosure, and standard or copper installation kit including 1" full port bronze ball valve, close nipple, and branch outlet. Provide with D-100 totalizing display module with BACnet interface, or equal.

2. Onicon F-3500 electromagnetic insertion flow meter, 316 stainless steel, weather tight aluminum enclosure, and standard or copper installation kit including 1" full port bronze ball valve, close nipple and branch outlet. Provide with D-100 totalizing display module with BACnet interface, or equal.
3. Onicon F4600 ultrasonic inline flow meter. Provide with integral LCD Display with BACnet MST/TP interface, or equal.

Q. Airflow Measuring Device Duct: Ebtron Gold Series C, thermal dispersion air flow array for duct mounting. Accuracy: Velocity +/- 2% of reading, Temperature +/- 0.15°F (0.01°C). Provide integral microprocessor-based transmitter with field selectable analog outputs for linear velocity, temperature or alarm. Transmitter shall also provide a concurrent RS-485 or Ethernet network interface and field selectable protocols, like: BACnet MS/TP, BACnet/IP, BACnet/Ethernet or Modbus.

2.7 ACTUATORS

A. Electronic Actuators for general valve duty

1. Manufactured, brand labeled or distributed by Belimo or equal.
2. Size for valve close off at 150 percent of total system (head) pressure for two-way valves; and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves
3. Coupling: directly couple and mount to valve stem, shaft ISO-style direct-coupled mounting pad. V-bolt dual nut clamp with a V-shaped, toothed cradle.
4. Overload protected electronically throughout rotation.
5. Fail-Safe Operation (as noted on the plans): Mechanical, spring-return mechanism. Electronic Fail-Safe Operation: Shall incorporate a visual indication of the fail-safe status on the face of the actuator. The power fail position shall be field adjustable between 0 to 100% in 10° increments. The electronic fail safe shall have a 2-10 second adjustable operational delay.
6. Power Requirements (Spring Return): 24 VAC, maximum 10 VA at 24-VAC or 8 W at 24-VDC (running). Maximum 1 VA at 24-V ac or 1 W at 24-V dc (holding).
7. Proportional Actuators shall be fully programmable through an onboard EEPROM by using an external cable and software interface.
8. Temperature Rating: -22 to +122ºF.
9. Housing: Minimum requirement NEMA type 2 mounted in any orientation.
10. Agency Listings: ISO 9001, cULus, CE or CSA.
11. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.

B. Electronic Actuators with torque requirements exceeding 360 inch-pounds

1. Manufactured, brand labeled or distributed by Belimo or equal by Bray.
2. The combination of valve and actuator shall meet the close-off requirements as specified in Section 2.16.H – Butterfly Valves.
3. Coupling: ISO 5211 mounting standards.
4. Overload Protection: A self-resetting thermal switch embedded in the motor.
5. Manual Override: Actuator shall be equipped with a hand wheel or shaft for manual override to permit operation of the actuator in the event of an electrical power failure
6. Power Requirements: 24VAC, 120VAC, or 230VAC single phase.
7. Auxiliary Switches: 2 SPDT rated 3A at 250 VAC.
8. Temperature Rating: -22 to +150ºF.
9. Duty Cycle Rated 75% minimum.
10. To ensure stable operation of chillers, cooling towers and boiler, isolation valve actuator stroke time shall be no less than 60 seconds.

11. Housing: Minimum requirement NEMA type 4X/ IP67 with an industrial quality coating. Actuator shall have an internal heater to prevent condensation within the housing. A visual indication beacon shall indicate position status of the device.
12. Agency Listing: ISO, CE, CSA
13. The manufacturer shall warrant for 2 years from the date of production.

C. Electronic Actuators for Dampers

1. Manufactured, brand labeled or distributed by Belimo or equal.
2. Size for torque required for damper seal at load conditions.
3. Outside air and exhaust air damper actuators shall be mechanical spring return. Capacitors or other non-mechanical forms of fail-safe are not acceptable. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.
4. Economizer actuators shall utilize analog control 2–10 VDC; floating control is not acceptable.
5. Electric damper actuators (including VAV box actuators) shall be direct shaft-mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or set-screw type fasteners are not acceptable.
6. One (1) electronic actuator shall be direct shaft-mounted per damper section. No connecting rods or jackshafts shall be needed. Small outside air and return air economizer dampers may be mechanically linked together if one (1) actuator has sufficient torque to drive both and damper drive shafts are both horizontal installed.
7. Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One (1) electronic actuator shall be direct shaft-mounted per damper section. (See below execution section for more installation details.)
8. The mechanical contractor shall furnish and size all automatic control dampers unless provided with packaged equipment. The sheet metal contractor shall install all dampers unless provided with packaged equipment.
9. All dampers used for modulating service shall be opposed blade type and arranged for normally open or normally closed operation as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop for effective throttling.
10. All dampers used for two-position or open-close control shall be parallel blade type arranged for normally open or closed operation as required.
11. Damper linkage hardware shall be constructed of aluminum or corrosion-resistant zinc and nickel-plated steel and furnished as follows:

    a. Bearing support bracket and drive blade pin extension shall be provided for each damper section. Sheet metal contractor shall install bearing support bracket and drive blade pin extension. Sheet metal contractor shall provide permanent indication of blade position by scratching or marking the visible end of the drive blade pin extension.
    b. Drive pin may be round only if V-bolt and toothed V-clamp is used to cause a cold weld effect for positive gripping. For single bolt or set-screw type actuator fasteners, round damper pin shafts must be milled with at least one side flat to avoid slippage.

12. Damper manufacturer shall supply alignment plates for all multi-section dampers.

2.8 CONTROL VALVES

A. Manufacturer:

1. Manufactured, brand labeled or distributed by Belimo, or equal by Bray.

2. The control valve assembly shall be provided and delivered from a single manufacturer as a complete assembly.

B. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional (except as noted).

C. Control Valve Actuators:

1. Size for valve close off at 150 percent of total system (head) pressure for two-way valves; and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves
2. Coupling: directly couple and mount to valve stem, shaft ISO-style direct-coupled mounting pad.

D. Pressure Independent Zone PIQCV Valves by Belimo or equal by Bray.

1. Forged brass body rated at no less than 360 PSI, 100 psi close off pressure stainless steel brass ball and stem, female NPT union ends, Teflon PTFE seats and O-rings, and PT ports.
2. Flow Characteristics: Equal percentage characteristic. 5-50 psi differential pressure range

E. Characterized Control Valves:

1. Sizing (Water):

   a. Three-Way Modulating as noted on drawings: Size using a pressure differential of not more than 4 psi differential at design flow.

2. NPS ¾" and Smaller for Terminal Units: Nickel plated forged brass body rated at no less than 600 psi, chrome plated brass ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
3. NPS 1" thru 2": Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
4. NPS 2-1/2 through 6": GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball, stainless steel blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.
5. Flow Characteristics: Equal percentage characteristics.
6. Six-way Control Valves shall have the following characteristics:

   a. NPS ½" and ¾": Nickel plated forged brass body rated at no less than 600 psi, dual chrome plated brass ball and blowout proof stems, and female NPT end fittings. Each three-way portion of the 6-way valve body shall have EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
   b. The six-way control valve shall be controlled by a rotary actuator for managing two media in a modulating application. The valve shall be closed to all flow at mid-rotation.

F. Butterfly Valves – Resilient Seat:

1. NPS 2 to 12: Valve body shall be full lugged cast iron 200 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange

standards. Disc-to-stem connection shall utilize an internal spline. The shaft shall be supported at four locations by RPTFE bushings.

2. NPS 14 and Larger: Valve body shall be full lugged cast iron 150 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize a dual-pin method to prevent the disc from settling onto the liner. The shaft shall be supported at four locations by RPTFE bushings.
3. Sizing:

    a. Two-Position Isolation: Line size or size using a pressure differential of 1 psi.
    b. For modulating by-pass application see plans for size and pressure drop at rated flow.

4. Close-Off Pressure Rating: NPS 2-12" 200 psi bubble tight shut-off. NPS 14 and larger, 150 psi bubble tight shut-off.

2.9 CONTROL ENCLOSURES

A. All controllers, power supplies and relays shall be mounted in enclosures.

B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

C. Enclosures shall be NEMA 4 when located in an outdoor environment.

D. Enclosures shall have hinged, locking doors.

E. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 0.125 inches thick and appropriately sized to make label easy to read.

2.10 UNINTERRUPTIBLE POWER SUPPLIES

A. UPS shall provide clean, reliable, noise-filtered power at all times and to protect and maintain systems operation throughout short term power interruptions of up to 15 minutes duration.

B. Acceptable Manufacturer is APC.

C. See System Architecture Drawings for locations

PART 3 - EXECUTION

3.1 Examination

A. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Architect or Engineer for resolution before starting rough-in work.

B. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.

C. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate Section 230900 work with work of others. BAS Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

3.2 Protection

A. BAS Contractor shall protect against and be liable for damage to work and to material caused by BAS Contractor's work or employees.

B. BAS Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 Coordination

A. Site:

1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, BAS Contractor shall correct conditions without extra charge.
2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

B. Test and Balance:

1. Provide Test and Balance Contractor a single set of necessary tools (if needed) to interface to control system for testing and balancing.
2. Train Test and Balance Contractor to use control system interface tools.
3. Provide a qualified technician to assist with testing and balancing the first 20 terminal units.
4. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.

C. Smoke Control:

1. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 23. Fire and smoke damper control is provided under Division 26.
2. Refer to Fire Life/Safety Event Matrix, sheet _____ for smoke control sequence of operation.

D. Coordination with Other Controls: Integrate with and coordinate controls and control devices furnished or installed by others as follows.

1. Each supplier of a controls product shall configure, program, start up, and test that product to meet the sequences of operation.
2. Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
3. BAS Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.

3.4 General Workmanship

A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.

B. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.

C. Install equipment in accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.

D. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

E. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.5 Field Quality Control

A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 230900 Article 1.5 (Reference Standards).

B. Continually monitor field installation for code compliance and workmanship quality.

C. BAS Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

3.6 Wiring

A. Low voltage (Class 2) wiring in concealed accessible spaces may be plenum rated and is not required to be enclosed in conduit.

B. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26, and manufacturer's recommendations. Where the requirements of Section 230900 differ from Division 26, Section 230900 shall take precedence.

1. Emergency Power: the BAS contractor shall confirm and coordinate emergency power requirements and ensure that all ASCs and/or factory-furnished DDC controllers for mechanical and plumbing equipment requiring emergency power are served by emergency power.

C. NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC and Division 26.

D. Low-voltage wiring shall meet NEC Class 2 requirements. Subfuse low-voltage power circuits as required to meet Class 2 current limit.

E. NEC Class 2 (low voltage current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.

F. Conduit: All conduit shall comply with the minimum requirements of the local authority having jurisdiction.

1. Install wiring in conduit where subject to mechanical damage and at levels below 10ft in mechanical, electrical, or service rooms.
2. Install wiring in conduit for wall sensors, and extend the conduit 6” above the ceiling. Install a bushing on the end of the conduit.
3. Install wiring in conduit above inaccessible ceilings.
4. Secure conduit with conduit clamps fastened to structure and spaced according to code requirements. Conduit and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.
5. Size conduit and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.
6. Include one pull string in each conduit 1 in. or larger.
7. Install Class 1 and Class 2 wiring in separate conduits. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.
8. Do not install wiring in conduit containing tubing.
9. Conceal conduit except within mechanical, electrical, or service rooms. Maintain minimum clearance of 6 in. between raceway and high-temperature equipment such as steam pipes or flues.
10. Adhere to requirements in Division 26 where conduit crosses building expansion joints.
11. Flexible metal conduit and liquid-tight flexible metal conduit shall not exceed 3 ft. in length and shall be supported at each end. Do not use flexible metal conduit less than 1/2 inch electrical trade size. Use liquid-tight flexible metal conduits in areas exposed to moisture.
12. Install conduits rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join conduit sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations outside of boxes with bushings.

G. Locate control transmitters, high/low limit switches, status relays, etc., in control panels only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.

H. Field wiring of all safety switches shall be brought back individually to discrete terminals in the control panel. Serial wiring of safeties is not permitted. Where safeties (e.g. freeze-stat) must be mounted in a plenum, the locations shall be clearly described in documents, and clearly field-labelled on access doors as per the diagram designation.

I. All terminal box controls (controller, power supply, actuators, sensors, pressure ports) shall be field-mounted to permit calibration and service from a single ladder location, coordinated wherever feasible with the furniture layout. Components shall not be installed in a manner that obstructs the factory-provided performance curve data.

J. Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.

K. BAS Contractor shall provide stepdown transformers.

3.7 Communication Wiring

A. BAS Contractor shall comply with all wiring requirements previously listed.

B. Communication wiring shall be low-voltage (class 2) wiring and shall comply with Article 3.6 (Wiring) for plenum rated installations.

C. Install communication wiring in separate conduit and enclosures from other Class 2 wiring.

D. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.

E. Verify entire network's integrity following cable installation using appropriate tests for each cable.

F. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.

G. Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.

H. Label communication wiring to indicate origination and destination.

I. Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

J. BACnet communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135.

K. All Ethernet cabling, routers, hubs, and switches for connecting 230900 furnished and installed control panels, servers and clients to the building owner's Ethernet network are the responsibility of the BAS contractor.

3.8 Installation of Sensors

A. Install sensors according to manufacturer's recommendations.

B. Mount sensors rigidly and adequately for operating environment.

C. Install room temperature sensors on concealed junction boxes properly supported by wall framing. For room sensors located exterior walls, furnish and install a ¼" thick, adhesive backed, foam insulating pad made by BAPI. Do not place room sensors in direct sunlight.

D. Air seal wires attached to sensors in their conduits in the wall to prevent sensor readings from being affected by air transmitted from other areas.

E. Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.

F. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 1 ft. of sensing element for each 1 ft 2) of coil area.

G. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.

H. Install outdoor air temperature sensors on north wall at designated location with sun shield.

I. Differential Air Static Pressure:

1. Supply Duct Static Pressure: Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
2. Return Duct Static Pressure: Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.

3. Building Static Pressure: Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.
4. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.
5. Pressure transducers, except those controlling VAV boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
6. Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.

J. Smoke detectors, freeze stats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow BAS software to monitor safety switch status.

3.9 Control System Checkout and Testing

A. Startup Testing: Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any or all startup testing.

1. Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Division 23.
2. Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.
3. Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.
4. Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
5. Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
6. Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated.
7. Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
8. Alarms and Interlocks:

   a. Check each alarm with an appropriate signal at a value that will trip the alarm.
   b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
   c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

3.10 Control System Demonstration and Acceptance

A. Demonstration: Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Section 3.9 (Control System Checkout and Testing). Furnish log documenting completion of startup tests.

1. Demonstration shall follow process submitted and approved under Submittals section of this specification. Complete approved checklists and forms for each system as part of system demonstration.
2. Demonstrate actual field operation of each sequence of operation. Provide at least two persons equipped with two-way communication. Demonstrate calibration and response of any input and output points requested by Owner's representative. Provide and operate test equipment required to prove proper system operation.
3. Demonstrate compliance with System Performance section of this specification.
4. Demonstrate compliance with sequences of operation through each operational mode.
5. Demonstrate complete operation of operator interface.
6. Demonstrate each of the following:

    a. DDC loop response: Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Further tuning will be required of each loop that displays unreasonably under- or over-damped control.
    b. Building fire alarm system interface.
    c. Furnish trend logs for each system: Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation in. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 15 minutes. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs, or shall be furnished in graphical Excel format.

7. Tests that fail to demonstrate proper system operation shall be repeated after BAS Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

3.11 Cleaning

A. Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.

B. On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.

C. On completion of work, check equipment furnished under this section for paint damage. Repair damaged factory-finished paint to match adjacent areas. Replace deformed cabinets and enclosures with new material and repaint to match adjacent areas.

3.12 AS-BUILT DOCUMENTATION

A. Project Record Documents. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:

1. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format. As-built floor plans indicating the routing of mstp communication wiring shall be included.
2. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
3. As-built versions of submittal Product Data.

4. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
5. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
6. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
7. Engineering, installation, and maintenance manuals that explain how to:
8. Design and install new points, panels, and other hardware.
9. Perform preventive maintenance and calibration.
10. Debug hardware problems.
11. Repair or replace hardware.
12. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
13. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
14. List of recommended spare parts with part numbers and suppliers.
15. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
16. Complete original-issue copies of furnished software, including operating systems, custom programming language, BAS software, and graphics software.
17. Licenses, guarantees, and warranty documents.
18. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
19. Owner training materials.

3.13 Training

A. Provide 32 hours of training for a designated staff of Owner's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.

B. Training shall enable students to accomplish the following objectives:

1. Proficiently operate system
2. Understand control system architecture and configuration
3. Understand DDC system components
4. Understand system operation, including DDC system control and optimizing routines (algorithms)
5. Operate workstation and peripherals
6. Log on and off system
7. Access graphics, point reports, and logs
8. Adjust and change system setpoints, time schedules, and holiday schedules
9. Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
10. Understand system drawings and Operation and Maintenance manual
11. Understand job layout and location of control components
12. Access data from DDC controllers
13. Operate portable operator's terminals
14. Create and change system graphics
15. Create, delete, and modify alarms, including configuring alarm reactions
16. Create, delete, and modify point trend logs (graphs) and multi-point trend graphs
17. Configure and run reports
18. Add, remove, and modify system's physical points

19. Create, modify, and delete application programming
20. Add operator interface stations
21. Add a new controller to system
22. Download firmware and advanced applications programming to a controller
23. Configure and calibrate I/O points
24. Maintain software and prepare backups
25. Interface with job-specific, third-party operator software
26. Add new users and understand password security procedures

C. Divide presentation of objectives into three sessions (1-13, 14-23, and 24-26). Participants will attend one or more of sessions, depending on knowledge level required.

1. Day-to-day Operators (objectives 1-13)
2. Advanced Operators (objectives 1-13 and 14-23)
3. System Managers and Administrators (objectives 1-13 and 24-26)

D. Provide course outline and materials according to Section 230900 (Submittals). Provide one copy of training material per student.

E. Instructors shall be factory-trained and experienced in presenting this material and shall present according to a pre-written curriculum.

F. Perform classroom training using a network of working controllers, representative of installed hardware.

G. Record training sessions on digital video for future use by the Owner.

END OF SECTION 23 09 00

SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping
2. Safety-valve-inlet and -outlet piping.

1.2 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping 125 psig at 200 deg F.
2. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air control devices.
3. Chemical treatment.
4. Hydronic specialties.

B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

C. Field quality-control test reports

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special- duty valves to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

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.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings: ASME B16.22.

1. 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:

a. Anvil International, Inc.
b. S. P. Fittings; a division of Star Pipe Products.

C. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, black steel with plain ends; ERW, grade B, and wall thickness as indicated

in Part 3 "Piping Applications" Article.

B. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

D. Forged-Steel Flanges and Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding, fittings.
3. Flanges: Raised face, slip-on or flat.

2.3 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to bejoined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hart Industries International, Inc.
b. Jomar International Ltd.
c. Matco-Norca, Inc.
d. Wilkins; a Zurn company.

2. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 125 psig minimum at 180 deg F, 150 psig, 250 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturer: Subject to compliance with requirements. Provide products by one of the following:

a. Capitol Manufacturing Company
b. Central Plastics Company
c. Matco-Norca, Inc.
d. Watts Regulator Co.; a Division of Watts Water Technologies, inc.
e. Wilkins; a Zurn Company

2. Description:

a. Standard: ASSE 1079
b. Factory-fabricated, bolted, companion-flange assembly
c. Pressure Rating: 175 psig
d. 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.
   b. Calpico, Inc.
   c. Central Plastics Company
   d. Pipeline Seal and Insulator, Inc.

2. Description:

   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure rating: 150 psig
   c. Gasket: Neoprene or phenolic
   d. Bolt Sleeves: Phenolic or polyethylene.
   e. 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
   b. Grinnell Mechanical Products
   c. Matco-Norca, Inc.
   d. Precision Plumbing Products, Inc.
   e. Victaulic Company

2. Description:

   a. Standard: IAPMO PS 66
   b. Electroplated steel nipple. Complying with ASTM F 1545.
   c. Pressure Rating: 300 psig at 225 deg F.
   d. End Connections: Male threaded
   e. Lining; Inert and non-corrosive, propylene.

2.4 AIR CONTROL DEVICES

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:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Taco.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.

6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS ½
5. Discharge Connection: NPS ¼
6. CWP Rating: 150 psig
7. Maximum Operating Temperature: 240 deg F

2.5 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 60-mesh startup strainer and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

C. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

D. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

E. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot Water, NPS 2 and Smaller: Above ground, use Type L drawn-temper copper tubing with soldered joints.

B. Hot Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded and flanged joints. Below ground, use pre-insulated pipe by Perma-Pipe or Rovanco with Schedule 40 black steel pipe carrier and welded joints. Use fewest possible joints below ground and within floor slabs.

C. Condensate Drain Lines: Type L drawn-temper copper tubing with soldered joints.

3.2 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

1. Shutoff Duty: Ball and butterfly valves.
2. Throttling Duty: Globe and valves.

B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

C. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

3.3 PIPING INSTALLATIONS

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.

B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

C. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

E. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

F. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff

coming out the top of the main pipe.

G. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

H. Anchor piping for proper direction of expansion and contraction.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports." Comply with requirements below for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for joint construction

requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC and CPVC piping.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be same as for equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If multiple, parallel control valves are installed, only one bypass is required.

D. Install ports for pressure and temperature gages at coil inlet connections.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
3. Check expansion tanks to determine that they are not air bound and that system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

3.9 ADJUSTING

A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

B. Perform these adjustments before operating the system:

1. Open valves to fully open position. Close coil bypass valves.
2. Check pump for proper direction of rotation.
3. Set automatic fill valves for required system pressure.
4. Check air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Check operation of automatic bypass valves.
7. Check and set operating temperatures of boilers to design requirements.
8. Lubricate motors and bearings.

3.10 CLEANING

A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers. Cleaning and flushing shall be performed by or reviewed and approved by Cx Agent in accordance with the following:

1. Confirm any pre-mix chemical requirements with water prior to addition to the system.
2. Circulate system for a minimum of 24-48 hours.
3. Thoroughly flush and drain system from its lowest point. Remove all cleaning compound from the system. A pH less than 8.0 and conductivity close to city water conductivity indicates sufficient flushing has been completed. Provide a phosphate test to assure full removal of the cleaner from the system.
4. Add recommended corrosion inhibitor (Nitrite, Molybdate or Sulfite-based products) into the system, keep rate per 1000 gallons system volume.
5. Have Water Treatment Vendor verify chemical inhibitor content of system.

END OF SECTION

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SECTION 23 21 16

HYDRONIC 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 special-duty valves and specialties for the following:

1. Hydronic specialty valves.
2. Air-control devices.
3. Strainers.
4. Suction Diffusers.
5. Buffer Tanks.
6. Connectors.

B. Related Requirements:

1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for expansion fittings and loops.
2. Section 230523 "Valves for HVAC Hydronic Piping" for specification and installation requirements for valves common to most piping systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Hydronic Specialty Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air-control devices.
3. Strainers.
4. Connectors.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Pressure Dependent (for Constant Volume Systems Only) Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bell & Gossett; a Xylem brand.
b. Armstrong Pumps, Inc.
c. Taco.
d. Grinnell Mechanical Products.
e. Griswold Controls.
f. Nexus Valve, Inc.
g. NuTech Hydronic Specialty Products.
h. Oventrop Corporation.
i. Tour & Andersson; available through Victaulic Company.

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.

3. Ball: Brass or stainless steel.

4. Plug: Resin.

5. Seat: PTFE.

6. End Connections: Threaded or socket.

7. Pressure Gage Connections: Integral seals for portable differential pressure meter.

8. Handle Style: Lever, with memory stop to retain set position.

9. CWP Rating: Minimum 125 psig.

10. Maximum Operating Temperature: 250 deg F.

B. Pressure Dependent (for Constant Volume Systems Only) Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bell & Gossett; a Xylem brand.
b. Armstrong Pumps, Inc.
c. Taco.
d. Grinnell Mechanical Products.

e. Griswold Controls.
f. Nexus Valve, Inc.
g. NuTech Hydronic Specialty Products.
h. Oventrop Corporation.
i. Tour & Andersson; available through Victaulic Company.
j. Victaulic Company.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.

3. Ball: Brass or stainless steel.

4. Stem Seals: EPDM O-rings.

5. Disc: Glass and carbon-filled PTFE.

6. Seat: PTFE.

7. End Connections: Flanged or grooved.

8. Pressure Gage Connections: Integral seals for portable differential pressure meter.

9. Handle Style: Lever, with memory stop to retain set position.

10. CWP Rating: Minimum 125 psig .

11. Maximum Operating Temperature: 250 deg F.

C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Apollo Valves; Conbraco Industries, Inc.
c. Armstrong Pumps, Inc.
d. Bell & Gossett; a Xylem brand.
e. Spence Engineering Company, Inc.
f. Watts; a Watts Water Technologies company.

2. Body: Bronze or brass.

3. Disc: Glass and carbon-filled PTFE.

4. Seat: Brass.

5. Stem Seals: EPDM O-rings.

6. Diaphragm: EPT.

7. Low inlet-pressure check valve.

8. Inlet Strainer: stainless steel, removable without system shutdown.

9. Valve Seat and Stem: Noncorrosive.

10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

D. Diaphragm-Operated Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMTROL, Inc.
    b. Apollo Valves; Conbraco Industries, Inc.
    c. Armstrong Pumps, Inc.
    d. Bell & Gossett; a Xylem brand.
    e. Spence Engineering Company, Inc.
    f. Watts; a Watts Water Technologies company.

1. Body: Bronze or brass.

2. Disc: Glass and carbon-filled PTFE.

3. Seat: Brass.

4. Stem Seals: EPDM O-rings.

5. Diaphragm: EPT.

6. Wetted, Internal Work Parts: Brass and rubber.

7. Inlet Strainer: stainless steel, removable without system shutdown.

8. Valve Seat and Stem: Noncorrosive.

9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Flowcon Americas LLC.
    b. Griswold Controls.
    c. Nexus Valve, Inc.
    d. NuTech Hydronic Specialty Products.
    e. Oventrop Corporation.

2. Body: Brass or ferrous metal.

3. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.

4. Combination Assemblies: Include bronze or brass-alloy ball valve.

5. Identification Tag: Marked with zone identification, valve number, and flow rate.

6. Size: Same as pipe in which installed.

7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.

8. Minimum CWP Rating: 175 psig.

9. Maximum Operating Temperature: 200 deg F.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMTROL, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett; a Xylem brand.
    d. Taco, Inc.

2. Body: Bronze.

3. Internal Parts: Nonferrous.

4. Operator: Screwdriver or thumbscrew.

5. Inlet Connection: NPS 1/2.

6. Discharge Connection: NPS 1/8.

7. CWP Rating: 150 psig.

8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMTROL, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett; a Xylem brand.
    d. Spirotherm, Inc.
    e. Taco, Inc.

2. Body: Bronze or cast iron.

3. Internal Parts: Nonferrous.

4. Operator: Noncorrosive metal float.

5. Inlet Connection: NPS 1/2.

6. Discharge Connection: NPS 1/4.

7. CWP Rating: 150 psig.

8. Maximum Operating Temperature: 240 deg F.

C. Bladder-Type Expansion Tanks (Full Acceptance Tanks Only):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMTROL, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett; a Xylem brand.
    d. Taco, Inc.

e. Wessels
f. Grundfos

2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

3. Bladder: Provide capability of replacing the bladder. Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

4. Drain: Provide drain connection.

5. Pressure Gauge: Provide integral pressure gauge.

6. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Coalescing-Type Air and Dirt Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armstrong Pumps, Inc.
b. Bell & Gossett; a Xylem brand.
c. Spirotherm, Inc.
d. Grundfos

2. Tank: Fabricated steel tank; ASME constructed and stamped for 150-psig working pressure and 270 deg F maximum operating temperature.

3. Coalescing Medium: [Copper] [Stainless steel]. The entire vessel shall suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location.

4. Air Vent: Threaded to the top of the separator.

5. Inline Inlet and Outlet Connections: Threaded for NPS 2 and smaller; Class 150 flanged connections for NPS 2-1/2 and larger.

6. Blowdown Connection: Threaded to the bottom of the separator.

7. Size: Match system flow capacity. In no case entering velocity exceeding 10 feet per second.

E. Coalescing-Type Air Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armstrong Pumps, Inc.
b. Bell & Gossett; a Xylem brand.
c. Spirotherm, Inc.
d. Grundfos

1. Tank: Fabricated steel tank; ASME constructed and stamped for 150-psig working pressure and 270 deg F (130 deg C) maximum operating temperature.

2. Coalescing Medium: [Copper] [Stainless steel].The entire vessel shall suppress

turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location.

3. Air Vent: Threaded to the top of the separator.

4. Inline Inlet and Outlet Connections: Threaded for NPS 2 and smaller; Class 150 flanged connections for NPS 2-1/2 and larger.

5. Blowdown Connection: Threaded to the bottom of the separator.

6. Size: Match system flow capacity. In no case entering velocity exceeding 10 feet per second.

F. Tangential-Type Air Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett; a Xylem brand.
   d. Taco, Inc.
   e. Grundfos

2. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.

3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.

4. Blowdown Connection: Threaded with strainer.

5. Size: Match system flow capacity.

2.3 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: Stainless-steel, [20] [40] [60]-mesh strainer, or perforated stainless-steel basket.

4. CWP Rating: 125 psig.

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: [40] [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig.

2.4 SUCTION DIFFUSERS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett; a Xylem brand.
   c. Taco, Inc.

2. Body: Cast Iron ASTM A126B, Class 125 or Ductile Iron ASTM A536, Class 300

3. Inlet and Outlet Connections: Flanged (Class 150) or grooved.

4. Removable straightening vanes to reduce turbulence made of wither carbon steel or 304 stainless steel.

5. Startup Sleeve Mesh: 20 stainless steel, removable.

2.5 BUFFER TANK

A. Buffer Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Niles Steel Tank
   b. AO Smith
   c. Cemline
   d. Wessels

2. Tank shall be ASME Code constructed and stamped in accordance with Section VIII of the ASME Code.

3. Tank shall be registered with the National Board of Boiler and Pressure Valve Inspectors and a certificate of shop inspection shall be furnished.

4. ASME working pressure shall be 125 psi.

5. Material of construction shall be Carbon Steel.

6. Tank shall be furnished with an air vent, a field installed insulated jacket, and thermometer.

7. Tank shall be supplied with four (4) angle legs welded 6" on the shell of the pressure vessel. Legs shall meet seismic zone 2 requirements.

2.6 CONNECTORS

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.

2. End Connections: Threaded or flanged to match equipment connected.

3. Performance: Capable of 3/4-inch misalignment.

4. CWP Rating: 150 psig.

5. Maximum Operating Temperature: 250 deg F.

C. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.

2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.

3. Performance: Capable of misalignment.

4. CWP Rating: 150 psig.

5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal. For use on constant volume systems only.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, to expansion tank with a 2 percent upward slope toward tank.

D. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

E. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.

2. Support tank from floor or structure above with sufficient strength to carry weight

of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION

SECTION 23 21 23

HYDRONIC 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. Close-coupled, end-suction centrifugal pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

C. HI: Hydraulics Institute

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.

2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 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. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the

following:

1. Armstrong Pumps, Inc.
2. Bell & Gossett
3. Grundfos
4. TACO Incorporated.

B. BASIS OF DESIGN: is Armstrong Pumps, Inc. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural, and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to updating energy compliance calculations.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

~~D.~~C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded flange end connections.

2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.

3. Pump Shaft: Stainless steel.

4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EDPM bellows and gasket. Include water slinger on shaft between motor and seal.

5. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.

6. Pump Bearings: Permanently lubricated ball bearings.

~~E.~~D. Motor: Single speed and rigidly mounted to pump casing.

1. 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. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

   a. Enclosure: Totally enclosed, fan cooled.
   b. Enclosure Materials: Cast iron.
   c. Motor Bearings: Permanently lubricated ball bearings.

   d. Efficiency: Premium efficient.
   e. NEMA Design: Class B.
   f. Service Factor: 1.15

2.2 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Pumps, Inc.
   2. Bell & Gossett
   3. Grundfos
   4. TACO Incorporated.

D. BASIS OF DESIGN: is Armstrong Pumps, Inc. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural, and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to updating energy compliance calculations.

E. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

F. Pump Construction:

   1. Casing: Radially split, cast iron, with drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and flanged connections.

   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.

   3. Pump Shaft: Stainless steel.

   4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

   5. Pump Bearings: Permanently lubricated ball bearings .

G. Motor: Single speed and rigidly mounted to pump casing with integral pump support.

   1. 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. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

      a. Enclosure: Totally enclosed, fan cooled.
      b. Enclosure Materials: Cast iron.
      c. Motor Bearings: Permanently lubricated ball bearings.
      d. Efficiency: Premium efficient.
      e. NEMA Design: Class B.
      f. Service Factor: 1.15.

2.3 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze startup and bronze or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Angle or straight pattern.
2. 175-psig pressure rating, cast -iron body, pump-discharge fitting.
3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
4. Brass gage ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4 and HI 2.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

E. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases.
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Pumps to be mounted on double deflection neoprene mounts sized for 0.3” static deflection (equal to Mason Industries ND) plus seismic snubbers.

3.3 ALIGNMENT

A. Perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install triple-duty valve on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

J. Install check valve and gate or ball valve on each condensate pump unit discharge.

K. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

L. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

A. 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. 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.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.

6. Start motor.

7. Open discharge valve slowly.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION

SECTION 23 23 00

REFRIGERANT 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.

B. Related Sections include the following:

1. Section 07 84 00 – Firestopping
2. Section 07 92 00 – Joint Sealants
3. Section 08 31 00 – Access Doors and Panels
4. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment
5. Section 23 05 53 – Identification for HVAC Piping and Equipment
6. Section 23 09 00 – Building Automation System

1.2 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerant piping valves and specialties.
3. Refrigerants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty.

1. Include pressure drop, based on manufacturer's test data, for the following:

a. Thermostatic expansion valves.
b. Solenoid valves.
c. Hot-gas bypass valves.
d. Filter dryers.
e. Strainers.
f. Pressure-regulating valves.

B. Sustainable Design Submittals:

1. Product Data: For refrigerants.

C. Shop Drawings:

1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
2. Refrigerant piping indicated on Drawings is schematic only. 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.
3. Show interface and spatial relationships between piping and equipment.

4. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

1.8 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A/R-454B:

1. Suction Lines for Air-Conditioning Applications: 300 psig
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

Copper Tube: ASTM B 88, Type K

A. Wrought-Copper Fittings: ASME B16.22.

B. Wrought-Copper Unions: ASME B16.22.

C. Brazing Filler Metals: AWS A5.8/A5.8M.

D. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Female copper tube ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Working Pressure Rating: Factory test at minimum 500 psig.

5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
1. End Connections: Socket, union, threaded, or flanged.
2. Maximum Opening Pressure: 0.50 psig.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.

5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and ac coil.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

G. Thermostatic Expansion Valves: Comply with AHRI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Reverse-flow option (for heat-pump applications).
7. End Connections: Socket, flare, or threaded union.
8. Working Pressure Rating: 500 psig.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: As recommended by Manufacturer.

7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and coil.
8. End Connections: Socket.
9. Set Pressure: As recommended by Manufacturer.
10. Throttling Range: As recommended by Manufacturer.
11. Working Pressure Rating: 500 psig.
12. Maximum Operating Temperature: 240 deg F.

I. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).

5. End Connections: Socket.

6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.

7. Maximum Pressure Loss: 2 psig.

8. Rated flow: As recommended by Manufacturer.

9. Working Pressure Rating: 500 psig.

10. Maximum Operating Temperature: 240 deg F.

2.4 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements,

1. Arkema Inc..
2. DuPont Fluorochemicals Div..
3. Genetron Refrigerants; Honeywell International Inc..
4. Mexichem Fluor Inc..

B. ASHRAE 34, R-410A

C. ASHRAE 34, R-454B

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A / R-454B

A. Suction Lines NPS 1-1/2 (DN 40) and Smaller: Copper, Type K (A) annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Suction Lines NPS 2 to NPS 3-1/2 (DN 50 to DN 90): Copper, Type K (A) drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Suction Lines NPS 4 (DN 100): Copper, Type K (A) drawn temper tubing and wrought-copper fittings with brazed joints

D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

E. Safety-Relief-Valve Discharge Piping: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage 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 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to 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.

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.

3.3 PIPING INSTALLATION

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 according to 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.

J. Refer to Section 230923 " Building Automation System" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. 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 083100 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. 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.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

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 according to Section 230553 "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 230517 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

V. Seal penetrations through fire and smoke barriers according to Section 078400 - “Fire Stopping."

W. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

X. Seal pipe penetrations through exterior walls according to Section 079200 - Joint Sealants for materials and methods.

Y. Identify refrigerant piping and valves according to Section 230553 - Identification for HVAC Piping and Equipment.

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of 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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

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.

3.5 HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.

2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.

3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet 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 the following maximum spacing and minimum rod diameters:

1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.

2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.

3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.

4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.

5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.

3.6 FIELD QUALITY CONTROL

A. Prepare test and inspection and prepare test reports.

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 shall maintain test pressure at the manifold gage 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.

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. 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.

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 except 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 232300

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 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 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 SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 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. 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 bottom of ducts.
5. Dimensions of main 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.

C. 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.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: 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. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Access panels.

B. Welding certificates.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to 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 D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

D. Exhaust system shall comply with CMC Section 505 and 506. Hot gas exhaust ductwork shall conform to CMC Section 816, 817 and 818. Both systems shall comply also to NFPA 91.

PART 2 - PRODUCTS

2.1 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.

B. Transverse Joints: Select joint types and fabricate according to 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."

C. Longitudinal Seams: Select seam types and fabricate according to 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."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 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."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

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 according to 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 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to 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."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt- welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to 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."

2.3 SHEET METAL MATERIALS

A. General Material Requirements:

1. 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 A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated on the “Duct Schedule” Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the “Duct Schedule” Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, 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.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

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. CertainTeed Corporation; Insulation Group.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.
e. Or approved equal.
f. Maximum Thermal Conductivity:

1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2. For outdoor application use 2-inch thick lining and for indoor application use 1-1/2-inch thick lining.
3. Line all ductwork as indicated on Drawings.
4. 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.
5. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Adhesive 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."

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. 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.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not

exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches 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.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm 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 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.

2.5 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 according to 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.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant 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."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
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, 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. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Sealant 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."
11. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
12. Service: Indoor or outdoor.
13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant 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."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg 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.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated 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, "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 A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated 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.

2.7 SEISMIC-RESTRAINT 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. Hilti Corp.
2. TOLCO; a brand of NIBCO INC.
3. Unistrut Corporation; Tyco International, Ltd.
4. Or approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by the Office of Statewide Health Planning and Development for the State of California.

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 A 603, galvanized-steel cables with end connections made of cadmium-plated 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: Reinforcing steel angle clamped 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 according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Coordinate duct layout and duct accessory arrangement with Drawings.

B. 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.

C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

D. Install ducts in maximum practical lengths.

E. Install ducts with fewest possible joints.

F. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

G. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

J. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

K. Ducts shall not be located in the dedicated space of Electrical equipment as defined by California Electrical Code Section 110.26

L. 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.

M. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

N. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

O. Duct sizes as indicated on the drawings are the net inside dimensions.

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.

D. Maintain consistency, symmetry, and uniformity in the 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 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" on the drawings. Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts before external insulation is applied.

C. Exposed ducts shall be sealed internally at joints. Sealant shall not be conspicuous at exposed ducts.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Verify attachment selection and spacing in first two paragraphs below with structural engineer.

C. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached. Obtain approval from project structural engineer.

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 thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

D. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "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 of each elbow and within 48 inches of each branch intersection.

E. Hangers Exposed to View: Threaded rod and angle or channel supports.

F. 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 interval of 16 feet.

G. 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.

H. Do not support ductwork from fans or any other equipment.

3.5 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."

1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
2. Brace a change of direction longer than 12 feet.

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 the Office of Statewide Health Planning and Development for the State of California.

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 the 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.

3.6 CONNECTIONS

A. Coordinate duct installations and specialty arrangements with Drawings.

B. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

C. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 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 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 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 representative duct sections totaling no less than the percentage of installed duct area identified on the "Duct Schedule" on the drawings.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. 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.
6. Give seven days' advance notice for testing.

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 according to "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.

3.9 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "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.

C. 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.

D. 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.
3. Air-handling unit internal surfaces and components including mixing box, coil section, drain pans, 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.

E. 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 according to NADCA 1992. 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 according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

A. Elbow Configuration:

1. 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."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

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) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

3. 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: Spin in.

4. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm 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. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Combination fire and smoke dampers.
7. Flange connectors.
8. Turning vanes
9. Duct silencers.
10. Remote damper operators.
11. Duct-mounted access doors.
12. Duct access panel assemblies
13. Flexible connectors.
14. Flexible ducts.
15. Duct accessory hardware.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For duct silencers, include pressure drop and dynamic insertion loss 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 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.

C. 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.

D. Source quality-control reports.

E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

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 AMCA 500-D testing for damper rating.

1.5 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.

PART 2 - EXECUTION

2.1 MATERIALS

A. 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 A 653/A 653M.

1. Galvanized Coating Designation: G60 for indoor and G90 for outdoor ducts.
2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

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. Air Balance Inc.; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Pottorff; a division of PCI Industries, Inc.
4. Ruskin Company.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: Hat-shaped, 0.052-inch- thick, galvanized sheet steel, with welded corners.

F. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Extruded vinyl, mechanically locked or Neoprene, mechanically locked.

I. Blade Axles:

1. Material: Galvanized steel.
2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Galvanized steel.

K. Return Spring: Adjustable tension.

L. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.
   a. Sleeve Thickness: 20 gauge minimum.
   b. Sleeve Length: 6 inches minimum.
6. Screen Mounting: Rear mounted.
7. Screen Material: Galvanized steel.
8. Screen Type: Bird.
9. 90-degree stops.

2.3 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.

2. Greenheck Fan Corporation.
3. Pottorff; a division of PCI Industries, Inc.
4. Ruskin Company.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: Hat-shaped, 0.064-inch- thick, galvanized sheet steel, with welded corners.

F. Blades:

1. Multiple, 0.025-inch-thick, roll-formed aluminum.
2. Maximum Width: 6 inches.
3. Action: Parallel.
4. Balance: Gravity.
5. Eccentrically pivoted.

G. Blade Seals: Vinyl or Neoprene.

H. Blade Axles: Galvanized steel.

I. Tie Bars and Brackets:

1. Material: Galvanized steel.
2. Rattle free with 90-degree stop.

J. Return Spring: Adjustable tension.

K. Accessories:

1. Flange on intake.
2. Adjustment device to permit setting for varying differential static pressures.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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. Air Balance Inc.; a division of Mestek, Inc.
   b. Greenheck Fan Corporation.
   c. Pottorff; a division of PCI Industries, Inc.
   d. Ruskin Company.

2. Standard leakage rating, Class 1, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Frame: Hat-shaped, 16 gauge, galvanized sheet steel.
   b. Round Frame and Sleeve, 20 gauge, galvanized sheet steel

c. Mitered and welded corners.
d. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:
   a. Rectangular dampers shall be single blade type in ducts up to 11” high and shall be opposed blade type in ducts 12” high and above.
   b. Round dampers shall be single blade type.
   c. Parallel-design.
   d. Stiffen damper blades for stability.
   e. Galvanized steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.
7. Bearings:
   a. Oil-impregnated bronze
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. Greenheck Fan Corporation.
   c. Pottorff; a division of PCI Industries, Inc.
   d. Ruskin Company.

2. Low-leakage rating, with linkage outside airstream, Class 1A, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Hat-shaped.
   b. 0.094-inch- thick, galvanized sheet steel.
   c. Mitered and welded corners.
   d. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized, roll-formed steel, 0.064 inch thick.

6. Blade Axles: Galvanized.
7. Bearings:
   a. Oil-impregnated bronze
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Blade Seals: Vinyl or Neoprene.
9. Jamb Seals: Cambered stainless steel.
10. Tie Bars and Brackets: Galvanized steel.
11. Accessories:
    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

C. Jackshaft:

1. Size: 1-inch 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.
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 thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.5 CONTROL DAMPERS

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. Greenheck Fan Corporation.
3. Ruskin Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Hat-shaped.
2. Galvanized-steel channels, 0.094 inch thick.
3. Mitered and welded corners.

D. Blades:

1. Multiple blade with maximum blade width of 8 inches.
2. Opposed-blade design.
3. Galvanized steel.
4. 0.064 inch thick.
5. Blade Edging: Closed-cell neoprene edging.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch-diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:

1. Oil-impregnated bronze.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Pottorff; a division of PCI Industries, Inc.
3. Ruskin Company.

B. Type: Fire dampers shall be labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 or 3 hours.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.7 COMBINATION FIRE AND SMOKE DAMPERS

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. Greenheck Fan Corporation.
2. Pottorff
3. Ruskin Company.

B. Combination fire and smoke dampers shall be labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 or 3 hours.

E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with interlocking corners and mounting flange.

F. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

G. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

H. Smoke Detector: Integral, factory wired for single-point connection.

I. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

J. Leakage: Class I.

K. Rated pressure and velocity to exceed design airflow conditions.

L. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.

M. Master control panel for use in dynamic smoke-management systems.

N. Damper Motors: Modulating and two-position action.

O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "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. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf .
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf .
7. Electrical Connection: 115 V, single phase, 60 Hz.

2.8 FLANGE CONNECTORS

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. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division 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. Gage and Shape: Match connecting ductwork.

2.9 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: 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"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Double wall.

F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.10 DUCT SILENCERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Price Industries
2. Dynasonics.
3. Industrial Noise Control, Inc.
4. Vibro-Acoustics.

B. General Requirements:
1. Factory fabricated.
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 according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

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 A 653/A 653M, galvanized sheet steel, 0.040 inch thick.

E. Round Silencer Outer Casing: ASTM A 653/A 653M, galvanized sheet steel.
1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.

F. Inner Casing and Baffles: ASTM A 653/A 653M, galvanized sheet metal, 0.034 inch thick, and with 1/8-inch-diameter perforations.
G. Special Construction:
   1. Suitable for outdoor use.
   2. High transmission loss to achieve STC 45.
H. Connection Sizes: Match connecting ductwork unless otherwise indicated.
I. Principal Sound-Absorbing Mechanism:
   1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
   2. Dissipative type with fill material.
      a. Fill Material: Moisture-proof nonfibrous material.
      b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
   3. Lining: None.
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. Source Quality Control: Test according to ASTM E 477.
   1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
   2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg, static pressure, whichever is greater.
L. Capacities and Characteristics:
   1. Configuration: Straight, 90-degree elbow
   2. Shape: Rectangular.
   3. Attenuation Mechanism: [Acoustical glass fiber] [Acoustical glass fiber with protective film liner] [Helmholtz resonator mechanism with no internal media].
   4. Maximum Pressure Drop: 0.25-inch wg.
   5. Casing:
      a. Attenuation: Standard.
      b. Outer Material: Galvanized steel
      c. Inner Material: Galvanized steel
   6. Velocity Range: 500-fpm to 2000-fpm
   7. End Connection: 1-inch slip joint.
   8. Length: Maximum 72”
   9. Face Velocity: < 2000 FPM

2.11 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   1. Pottorff.
   2. Young Regulator Company.
   3. Metropolitan Air Technology.
B. Description: Cable system designed for remote manual and electro damper adjustment. Provide with electro-balancer for lengths greater than 12 feet.
C. Tubing: Brass.
D. Cable: Steel for manual; plenum rated wire for electro.
E. Wall-Box Mounting: Recessed.
F. Wall-Box Cover-Plate Material: Steel.
G. Accessories: Electro-balancer: battery powered hand-held remote.

2.12 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Greenheck Fan Corporation.
3. Pottorff; a division of PCI Industries, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 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. Vision panel.
   d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48: Continuous and two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

2.13 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. 3M.
2. Ductmate Industries, Inc.
3. Flame Gard, Inc.

B. Labeled according to UL 1978 by an NRTL.
C. Panel and Frame: Minimum thickness 0.0528-inch 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.
F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.14 FLEXIBLE CONNECTORS

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. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd. .
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd. .
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg. F.

G. 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. Outdoor 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.
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 movement at start and stop.

2.15 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Casco Silentflex II.
2. Thermaflex M-KE
3. Thermaflex G-KM

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 positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with Title 24.

2.16 DUCT ACCESSORY HARDWARE

A. 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.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories 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 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 backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. 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 in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Connect ducts to duct silencers with flexible duct connectors.

I. 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. Downstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft 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. At each change in direction and at maximum 50-foot spacing.
8. Downstream from turning vanes.
9. Upstream or downstream from duct silencers.

10. Control devices requiring inspection.
11. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

L. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. Connect terminal units to supply ducts directly. Do not use flexible ducts to change directions.

O. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

Q. Install duct test holes where required for testing and balancing purposes.

R. 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 movement during start and stop of fans.

S. All equipment and components requiring access above hard lid ceiling shall be provided with adequate service clearance and ceiling access panels. Coordinate ceiling access panel location based upon installation location in field and in accordance with Section 08 31 00 – Access Doors and Panels.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 23 34 23

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

Section Includes:

1. Centrifugal roof ventilators.
2. Ceiling-mounted ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. 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.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans 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. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

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.

1.8 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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.9 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Greenheck Fan Corporation.
2. Loren Cook Company
3. Twin City Fans

B. Basis of Design is Greenheck. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle, square, one-piece, aluminum base with venturi inlet cone.

Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

F. Accessories:

1. Variable-Speed 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 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.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.

2. Overall Height: 8 inches**.**

4. Sound Curb: Curb with sound-absorbing insulation.

5. Pitch Mounting: Manufacture curb for roof slope.

6. Metal Liner: Galvanized steel.

H. Provide with VariGreen ECM direct drives.

2.2 CEILING-MOUNTED VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Greenheck Fan Corporation.

2. Loren Cook Company

3. Panasonic

B. Basis of Design is Greenheck. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. Grille: Aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.

3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.

4. Motion Sensor: Motion detector with adjustable shutoff timer.

5. Filter: Washable aluminum to fit between fan and grille.

6. Isolation: Rubber-in-shear vibration isolators.

7. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 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."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Connect wiring according to Division 26.

3.3 FIELD QUALITY CONTROL

A. 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.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.

2. 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.

3. Verify that cleaning and adjusting are complete.

4. 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.

5. Adjust belt tension.

6. Adjust damper linkages for proper damper operation.

7. Verify lubrication for bearings and other moving parts.

8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.

10. Shut unit down and reconnect automatic temperature-control operators.

11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

C. Lubricate bearings.

END OF SECTION

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SECTION 23 36 00

AIR TERMINAL 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. Shutoff, single-duct air terminal units.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: 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 SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems".

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.

1.4 SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.

1. Air terminal units.
2. Liners and adhesives.
3. Sealants and gaskets.
4. Seismic-restraint devices.

B. Shop Drawings: For air terminal units. 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.
3. Hangers and supports, including methods for duct and building attachment, seismic restraints and vibration isolation.

C. Delegated-Design Submittal:

1. Materials, fabrication, assembly, and spacing of hangers and supports.

2. 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.

D. 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. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

E. Field quality-control reports.

F. Operation and Maintenance Data: For air terminal units 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. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.5 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: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Price Industries.
2. Titus, and Krueger may be considered.

B. BASIS OF DESIGN: is Price Industries. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations.

C. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

D. Casing: 22 gauge galvanized single wall.

1. Casing Lining: Adhesive attached, 1-inch thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a

maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

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 parts requiring service, adjustment, or maintenance; with airtight gasket. Access upstream and downstream of hot water coils shall be provided. Access panels shall be of sufficient sixe to permit cleaning of coil.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from 0 to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.

F. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally open

G. Attenuator Section: 0.034-inch steel sheet.

1. Lining: Adhesive attached, 1-inch-thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

I. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Division 25 specifications and shall have the following features:

1. Damper Actuator: 24 V, powered closed, spring return open.
2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

a. Occupied and unoccupied operating mode.
b. Remote reset of airflow or temperature set points.
c. Adjusting and monitoring with portable terminal.
d. Communication with temperature-control system specified in Division 25 specifications.

2.2 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Steel Cables: Galvanized steel complying with ASTM A 603.

C. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

D. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.3 SEISMIC-RESTRAINT DEVICES

A. 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.

B. 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.

C. Restraint Cables: ASTM A 603, galvanized steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; with an automatic-locking and clamping device or double-cable clips.

D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Hangers Exposed to View: Threaded rod and channel supports.

C. 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.

3.3 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with ASCE/SEI 7.

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 seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

E. 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.

F. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the 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. Install heavy-duty sleeve anchors 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.

3.4 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Section 23 21 13 "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Connect ducts to air terminal units according to Section 23 31 13 "Metal Ducts." Coordinate duct installations and specialty arrangements with Drawings.

3.5 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

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.

B. Air terminal unit will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00

SECTION 23 37 13

DIFFUSERS, 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 core ceiling diffusers.
2. Fixed and adjustable face grilles.
3. Linear slot diffusers.
4. Diffuser/grille types not listed herein shall be provided as scheduled on the drawings.

B. Related Sections:

1. Division 23 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

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, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

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 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

    a. Price Industries
    b. Titus and Krueger may be considered.

3. BASIS OF DESIGN: is Price Industries. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations.

2.2 CEILING DIFFUSERS

A. Square Ceiling Diffusers

1. Material: Steel unless noted otherwise on plans.
2. Finish: Baked enamel or powder coat, white. Where indicated on drawings, diffuser color shall be selected by architect.
3. Face Size: As scheduled.
4. Face Style: Adjustable core.
5. Mounting: Concealed. Lay-in panel, plaster mounting panel accessory for gypsum board ceilings.
6. Pattern: 4-way unless noted otherwise on plans.

2.3 REGISTERS AND GRILLES

A. Fixed and Adjustable Face Grille

1. Material: Steel unless noted otherwise on plans.
2. Finish: Baked enamel or powder coat, white.
3. Face Arrangement: ¾ inch blade spacing, 30 to 45 degree angle.
4. Core Construction: Integral.
5. Mounting: Concealed. Lay-in panel, plaster mounting panel accessory for gypsum board ceilings.

2.4 LINEAR SLOT OUTLETS

A. Linear slot diffusers

1. Devices shall be specifically designed for variable-air volume flows.
2. Material - Shell: Aluminum.
3. Material - Pattern Controller and Tees: Aluminum.
4. Finish - Face and Shell: Baked enamel or powder coat black.
5. Finish - Pattern Controller: Baked enamel or powder coat black.
6. Slot Width: Up to 2-1/2 inches.
7. Number of Slots: One or Two.
8. Section Length: 48 inches minimum, 72 inches maximum.
9. Accessories:
    a. Concealed plaster frame, concealed mud-in frame mounting.
    b. Flush mounting, for baffle ceiling installation.
    c. T-bar mounting.
    d. Lined plenum box
        1) Construction
            a) The plenums shall be constructed of zinc coated steel.
            b) The plenum assembly shall have straight shoulders for enhanced throw characteristics.
            c) The plenum assembly shall have a side inlet configuration in sizes to fit slot diffusers with one to four slots.
            d) The plenum shall be available to suit both drywall and lay-in applications.
            e) The plenum shall be internally lined with 1/4-inch-thick fiber free insulation.

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be 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, registers, and grilles 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, 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 diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 64 23.13

AIR SOURCE HEAT PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes design, performance criteria, refrigerants, controls, and installation requirements for air-cooled rotary scroll packaged heat pumps.

1.2 REFERENCES

A. AHRI 550/590 - Standard for Water Chilling Packages using the Vapor Compression Cycle

B. AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment

C. ASHRAE 15 - Safety Code for Mechanical Refrigeration

D. ASHRAE 90.1 - Energy Efficient Design of New Buildings

E. UL 1995 - Central Cooling Air Conditioners

F. ASTM B117 - Standard Method of Salt Spray (Fog) Testing

G. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

H. ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products

I. ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments

J. ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings.

K. ISO 9001

L. California Administrative Code - Title 24

1.3 SUBMITTALS

A. Submit dimensional plan and elevation view drawings, weights and loadings, required clearances, location and size of all field connections, electrical requirements and wiring diagrams.

B. Submit product data indicating rated capacities, accessories and any special data.

C. Submit manufacturer's installation instructions.

1.4 REGULATORY REQUIREMENTS

A. Heat pump shall have valid OSP (HCAI) certification to comply with required seismic requirements.

1. If manufacturer does not have valid OSP, site specific OSP can be obtained for this project. Heat pump used for testing cannot be provided to this project. All costs for OSP

certification and delays to construction schedule shall be burdened by heat pump manufacturer.

B. Comply with codes and standards specified.

C. Heat pump must be built in an ISO 9001 classified facility.

1.5 VERIFICATION OF CAPACITY AND EFFICIENCY

A. All proposals for heat pump performance must include an AHRI approved selection method. Verification of date and version of computer program selection or catalog is available through AHRI.

B. Heat pump shall be factory pressure tested, evacuated and fully charged with R-454B refrigerant and oil, and be operational run tested with water flowing through the vessels.

1.6 DELIVERY, HANDLING AND STORAGE

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting heat pumps.

B. Heat pump shall be capable of withstanding -40ºF to 158ºF storage temperatures for an indefinite period of time.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. WaterFurnace
   2. Jetson
   3. Multistack
   4. Trane

B. BASIS OF DESIGN: is WaterFurnace. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations.

2.2 HEAT PUMP DESCRIPTION

A. The contractor shall furnish and install air-source heat pump with scroll compressors as shown as scheduled on the contract documents. The heat pump shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

2.3 HEAT PUMP OPERATION

A. Heat pump shall be able to start and operate in ambient conditions from 32ºF (0ºC) to 125ºF (52ºF). Wide ambient operation is accomplished with factory installed and tested protection.

B. Heat pump shall be capable of operation with a leaving solution temperature of 140ºF at 35°F ambient air temperature and operate down to -4°F ambient air temperature.

C. Heat pump shall be capable of running in cooling mode from -4°F to 118°F and -13°F to 109°F ambient temperature in heating mode. Simultaneous mode shall be capable of running from -4°F to 118°F ambient temperature.

D. Heat pump shall provide evaporator freeze protection and low limit control to avoid low evaporator refrigerant temperature trip-outs during critical periods of heat pump operation. Whenever this control is in effect, the controller shall indicate that the heat pump is in adaptive mode. If the condition exists for more than 30 seconds, a limit warning alarm relay shall energize.

2.4 COMPRESSORS

A. Construct heat pump using fully hermetic scroll type compressors with R454B optimized and dedicated scroll profile with vapor injection.

B. Provide direct drive motor cooled by suction gas with only three major moving parts and a completely enclosed compression chamber that leads to increased efficiency.

C. Each compressor shall have overload protection internal to the compressor.

D. Each compressor shall include: centrifugal oil pump, oil level sight glass and oil charging valve.

E. Each compressor will have crankcase heaters installed and properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.

F. Compressors shall be variable speed.

G. Compressors shall be provided with sound reducing compressor wrap.

H. Compressors shall be provided on individual circuits. There shall be 2 individual refrigerant circuits on each module of heat pumps. Each compressor/circuit shall be able to operate in different modes simultaneously without effecting the other circuit.

2.5 WATER COIL HEAT EXCHANGER

A. The heat exchanger shall be a high efficiency, brazed plate-to-plate type heat exchanger consisting of parallel plates. Braze plates shall be stainless steel with copper braze material.

B. The water side working pressure shall be rated at 150 psig (10.3 bar) and tested at 1.5 times maximum allowable water side working pressure.

C. The refrigerant side working pressure shall be rated at 460 psig (29.6 bars) and tested at 1.1 maximum allowable refrigerant side working pressure.

D. Insulate the water coil with a minimum of 1.0 inch (K=0.28) UV rated insulation. If the insulation is field installed, the additional money to cover material and installation costs in the field should be included in the bid.

E. Water coil heaters shall be factory installed and shall protect heat pump down to -20ºF (-29ºC). Contractor shall wire separate power to energize heat tape and protect evaporator while heat pump is disconnected from the main power.

F. Provide water drain connection, vent and fittings. Factory installed leaving water temperature control and low temperature cutout sensors.

G. Water connections shall be grooved pipe.

H. Proof of flow shall be provided by the equipment manufacturer, mechanically installed and electrically wired, at the factory of origin.

2.6 FANS

A. Low sound fans shall be dynamically balanced and direct driven.

B. All condenser fan TEAO motors have permanently lubricated ball bearings and external overload protection.

C. All fans shall be variable speed EC motor driven.

2.7 AIR COIL HEAT EXCHANGER

A. The coils shall consist of copper tubes mechanically bonded into plate-type aluminum fins with factory coating to shed water during defrost and protect against corrosion.

B. The coils shall have an integral sub-cooling circuit and shall be designed for at least 600 psig working pressure.

C. Coils shall sit on condensate drain pan integral to the steel frame. Drain pan shall have minimum of 4, 1” drain connections to pipe condensate from defrost to drain.

1. If factory drain pan under coils is not provided, manufacturer shall provide 316 stainless steel drain pan under entire heat pump with 3” turned up lip with welded corners. Minimum of 4 drain connections shall be provided. Heat pump shall be mounted so condensate drain piping can provide proper slope to drain.

2.8 ENCLOSURES CONSTRUCTION

A. Units shall be constructed of a painted galvanized steel frame with painted galvanized steel panels and access doors.

B. Heat pump panels, base rails and control panels shall be finished with a baked on powder paint. Control panel doors shall have door stays.

C. Mount starters and Terminal Blocks in a UL 1995 rated weatherproof panel provided with full opening access doors. If a circuit breaker is chosen, it should be a lockable, through-the-door type with an operating handle and clearly visible from outside of heat pump indicating if power is on or off.

D. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B117.

2.9 HEAT PUMP MOUNTED STARTER

A. The starter shall be variable speed, factory-mounted and fully pre-wired to the compressor motor(s) and control panel.

B. Unit shall have a single point power connection for up to 8 modules.

C. A control power transformer shall be factory-installed and factory-wired to provide unit control power.

D. Control panel shall be dead front construction for enhanced service technician safety

E. Unit wiring shall run in liquid-tight conduit.

F. A molded case standard interrupting capacity circuit breaker shall be factory pre-wired with terminal block power connections and equipped with a lockable external operator handle, making it available to disconnect the heat pump from main power.

G. High short circuit current rating (SCCR) of 65kA heat pumps with selection of high fault protection device.

2.10 REFRIGERANT CIRCUIT

A. All heat pumps shall have 2 independent refrigeration circuits, each with 1 variable speed compressor on each circuit.

B. Provide for refrigerant circuit:

1. Liquid line shutoff valve
2. Discharge service valve
3. Filter
4. Liquid line sight glass.
5. Electronic expansion valve sized for maximum operating pressure
6. Charging valve

C. Full operating charge of R-454B and oil.

2.11 CONTROLS

A. Each heat pump module shall have high capacity controller capable of being master controller for all heat pump modules on project. Master controller shall be designated by installing contractor during startup. In the case the master controller fails, another modules controller shall automatically become master controller.

B. Defrost shall be automatically controller by unit.

1. Defrost shall operate to not pull heat from the heating hot water system.
2. When module goes into defrost, one circuit shall operate in heating mode while other circuit shall operate in cooling mode to melt ice off of coil without effecting heating hot water system.
3. If heat pump cannot operate in defrost without effecting heating hot water system, an additional module shall be provided to provide offset module in defrost. Added structural,

electrical, piping, controls, installation and any other costs shall be paid by heat pump manufacturer.

C. Factory-mounted to the control panel door, the operator interface has an LCD touch-screen display in NEMA3R enclosure.

D. Heat pump shall provide BACnet (IP or MSTP) interface.

E. Display shall consist of a menu driven interface with easy touch screen navigation to organized sub-system reports for compressor, evaporator, and motor information as well as associated diagnostics.

F. The heat pump control panel shall provide password protection of all set-points

G. Supply water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each heat pump by the heat pump manufacturer.

H. The front of the heat pump control panel shall display the following in clear language, without the use of codes, look-up tables, or gauges:

1. Run time.
2. Number of starts.
3. Current heat pump operating mode.
4. Supply water set point and set point source.
5. Electrical current limit set point and set point source.
6. Entering and leaving evaporator water temperatures.
7. Saturated evaporator and condenser refrigerant temperatures.
8. Evaporator and condenser refrigerant pressure.
9. Differential oil pressure.
10. Phase reversal/unbalance/single phasing and over/under voltage protection.
11. Low chilled water temperature protection.
12. High and low heating water temperature protection.
13. High and low refrigerant pressure protection.
14. Load limit thermostat to limit compressor loading on high return water temperature.
15. Condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, condenser pressure, and differential pressure to optimize heat pump efficiency.
16. Display diagnostics.
17. Compressors: Status (on/off), %RLA, anti-short cycle timer, and automatic compressor lead-lag.

I. On heat pump, mount weatherproof control panel, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer.

J. The heat pump controller shall utilize a microprocessor that will automatically take action to prevent heat pump shutdown due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.

K. Provide the following safety controls with indicating lights or diagnostic readouts.

1. Low chilled water temperature protection.
2. High refrigerant pressure.

3. Loss of chilled water flow.
4. Contact for remote emergency shutdown.
5. Motor current overload.
6. Phase reversal/unbalance/single phasing.
7. Over/under voltage.
8. Failure of water temperature sensor used by controller.
9. Compressor status (on or off).

L. Provide the following operating controls:

1. A variable method to control capacity in order to maintain leaving chilled water temperature based on PI algorithms. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes. If a greater than 5 minute start-to-start, or greater than 2 minute stop-to-start timer is included, hot gas bypass shall be provided to insure accurate chilled water temperature control in light load applications.
2. Chilled water pump output relay that closes when the heat pump is given a signal to start.
3. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trip outs.
4. High ambient unloader pressure controller that unloads compressors to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.
5. Compressor current sensing unloader heat pump that unloads compressors to help prevent current overload nuisance trip outs.
6. Low ambient lockout control with adjustable setpoint.
7. Condenser fan sequencing which adjusts the speed of all fans automatically in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing heat pump efficiency.

M. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:

1. Leaving chilled water setpoint adjustment from LCD input
2. Entering and leaving chilled water temperature output
3. Pressure output of condenser
4. Pressure output of evaporator
5. Ambient temperature output
6. Voltage output
7. Current limit setpoint adjustment from LCD input.

N. The heat pump control panel shall provide leaving chilled water temperature reset based upon return water temperature.

O. Digital Communications to BAS system shall consist of a BACnet MS/TP interface via a single twisted pair wiring.

P. The heat pump control panel shall provide an alarm relay output that shall energize whenever a fault requiring manual reset is detected by the panel.

2.12 SOUND

A. Acoustics: Manufacturer must provide both sound power and sound pressure data in decibels. Sound pressure data per AHRI 370 must be provided at full load.

B. If manufacturer cannot meet the noise levels, sound attenuation devices and/or barrier walls must be installed to meet this performance level.

C. Provide acoustical treatment for compressor.

2.13 ACCESSORIES

A. Heat pump shall have full architectural louvers panels.

B. Heat pump shall ship with elastomeric isolators

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's requirements.

1. Level the heat pump using the base rail as a reference. The heat pump must be level within 1/2" in over the entire length and width. Use shims as necessary to level the heat pump.

2. Unit to be mounted on 3/4" neoprene waffle pads equal to Mason Industries SW with isolated bolting via neoprene washer/bushing elements equal to Mason Industries HG.

3.2 SERVICE AND START-UP

A. Startup - Provide all labor and materials to perform startup. Startup shall be performed by a factory-trained technician from the original equipment manufacturer (OEM). Technician shall confirm that equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty. This shall be done in strict accordance with manufacturer's specifications and requirements. Third-party service agencies are not permitted.

B. A start-up log shall be furnished by the factory approved start-up technician to document the heat pump's start-up date and shall be signed by the owner or his authorized representative prior to commissioning the heat pumps.

C. Train owner’s maintenance staff in standard operation and error review by factory-authorized agent. Training to be provided on-site after startup of equipment, and include review of owner’s manual and in-field operations. Schedule training with ownership via general contractor within two (2) weeks of substantial completion.

D. Heat pump manufacturers shall maintain service capabilities no more than 90 miles from the jobsite.

E. Provide local service agent with direct access to factory support on equipment.

END OF SECTION 23 64 23

SECTION 23 74 00

PACKAGED ROOFTOP OUTDOOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Packaged Rooftop Outdoor HVAC Equipment consists of furnishing transportation, labor, material, and equipment to furnish and install the following rooftop air conditioners:

1. Rooftop air conditioners larger than 20 tons.

1.2 REFERENCES

A. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)

B. Underwriters Laboratories, Incorporated (UL)

1.3 ABBREVIATIONS

A. DDC: Direct-digital controls.

1.4 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Prepare the following by or under the supervision of a qualified professional engineer:

1. Design Calculations: Calculate requirements 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. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For rooftop air conditioners to include in emergency, operation, and maintenance manuals.

E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop air conditioners and are based on the specific system indicated.

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. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

D. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

F. ARI Certification: Units shall be ARI certified and listed.

G. ARI Compliance for Units with Capacities 135,000 Btuh and More: Rate rooftop air-conditioner capacity according to ARI 340/360, "Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment."

1. Sound Power Level Ratings: Comply with ARI 270, "Sound Rating of Outdoor Unitary Equipment."

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in ROOF ACCESSORIES Section.

C. Coordinate size, location, and installation of rooftop air-conditioner manufacturer's roof curbs and equipment supports with roof installer.

1. Coordinate installation of restrained vibration isolation roof-curb rails.

1.7 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 and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
3. Inspect internal insulation.
4. Verify that labels are clearly visible.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Clean outside coil and inspect for construction debris.

9. Adjust vibration isolators.
10. Inspect operation of barometric dampers.
11. Lubricate bearings on fan.
12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
13. Adjust fan belts to proper alignment and tension.
14. Start unit according to manufacturer¢s written instructions.

    a. 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 outside-air dampers for proper stroke and interlock with return-air dampers.
20. Start refrigeration system and measure and record the following:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outside-air, dry-bulb temperature.

21. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
22. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.

23. Verify operation of remote panel, including pilot-light operation and failure modes. Inspect the following:

    a. High-limit heat exchanger.
    b. Warm-up for morning cycle.
    c. Freezestat operation.
    d. Economizer to limited outside-air changeover.
    e. Alarms.

PART 2 - PRODUCTS

2.1 ROOFTOP AIR CONDITIONERS LARGER THAN 20 TONS

A. MANUFACTURERS: Subject to compliance with requirements, provide products by one of the following:

1. Daikin
2. Trane
3. Aaon
4. Carrier

B. BASIS OF DESIGN: is Daikin. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations.

C. GENERAL DESCRIPTION

1. Furnish as shown on plans, packaged VAV with duct static pressure control Cooling unit(s). Unit performance and electrical characteristics shall be per the job schedule.
2. Configuration: Fabricate as detailed on prints and drawings.
3. The complete unit shall be ETL listed.
4. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Units shall be of a modular design with factory installed access sections available to provide maximum design flexibility.
5. Unit shall be completely factory assembled and shipped in one piece.
6. Unit to be shipped fully charged with R-454 or R-32.
7. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include final balancing of all fan assemblies, a refrigeration circuit runtest, a unit control system operations checkout, a unit refrigerant leak test, and a final unit inspection.
8. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
9. Performance: All scheduled capacities and face areas are the minimum accepted value. All scheduled amps, KW, and HP are maximum accepted values that allow scheduled capacity to be met.

D. CABINET

1. Unit cabinet shall be designed to operate at total static pressures up to 6.5 inches w.g.
2. Standard double-wall construction for all side wall access doors and floor areas shall be provided with heavy gauge solid galvanized steel inner liners to protect insulation during service and maintenance. Insulation on ceiling and end panels shall be secured with adhesive and mechanical fasteners. Insulation shall be a minimum of 1” thick, ¾ lb. density neoprene coated glass fiber insulation.
3. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished surface to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
4. Service doors shall be provided on both sides of each section in order to provide user access to all unit components. Service doors shall be constructed of heavy gauge galvanized steel with galvanized steel interior liners. All service doors shall be mounted on multiple, stainless steel hinges and shall be secured by a stainless steel latch system that is operated by a single handle. The latch system shall feature a staggered engagement for ease of operation and a safety catch shall protect the user from injury in case a positive pressure door is opened while the fan is operating. Removable panels, or doors secured by multiple, mechanical fasteners are not acceptable.
5. The unit base frame shall be constructed of 13 gauge pre-painted galvanized steel.
6. The unit base shall overhang the roof curb for positive water runoff and shall have a formed recess that seats on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base with lifting holes to accept cable or chain hooks.

E. FANS

1. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self- aligning, grease lubricated ball bearings shall be used. Bearings shall be sized to provide an L-50 life at 200,000 hours. Entire assembly shall be completely isolated from unit and fan board by double deflection rubber-in-shear isolators, or by optional 2" deflection spring isolation. Fixed pitch V-belt drives with

matching belts shall be provided. V-belt drives shall be selected at the manufacturers standard service factor.

2. Fan motors shall be heavy-duty 1800 rpm premium efficiency and VFD rated. Fan motors to have grease lubricated ball bearings. Motors shall be mounted on an adjustable base that provides for proper alignment and belt tension adjustment.
3. Motor shall be Open Drip-proof.
4. Airfoil supply fans.

    a. A single width, single inlet (SWSI) airfoil centrifugal supply air fan shall be provided. The fan shall be Class II construction. The fan wheel shall be Class II construction and fabricated from heavy-gauge aluminum with fan blades continuously welded to the back plate and end rim. The fan shall be mounted using shafts and hubs with mating keyways.
    b. Multiple supply fans may be installed in parallel (in a fan array) in incremental sizes that add up to the total scheduled airflow of the unit. If a fan array is provided within an air handler, provide internal gravity isolation dampers for each fan for servicing access.

5. Airfoil return fans.

    a. A single width, single inlet (SWSI) airfoil centrifugal return air fan shall be provided. The fan shall be Class II construction. The fan wheel shall be Class II construction and fabricated from heavy-gauge aluminum with fan blades continuously welded to the back plate and end rim. The fan shall be mounted using shafts and hubs with mating keyways.
    b. Standalone exhaust or relief fans are not acceptable, but may be integrated with return fan. Exhaust/relief fans are to have the same construction as return fans.
    c. Multiple return fans may be installed in parallel (in a fan array) in incremental sizes that add up to the total scheduled airflow of the unit..

F. VARIABLE AIR VOLUME CONTROL

1. Separate electronic variable frequency drives shall be provided for each fan. Drives shall be independent. Drives shall be cooled by the filtered mixed air stream. The completed unit assembly shall be listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly complete with a single handle latch mechanism. Mounting arrangements that expose drives to high temperature, unfiltered ambient air are not acceptable. The unit manufacturer shall install all power and control wiring.
2. In a fan array arrangement, two fans may be controlled by a single VFD drive, but each fan is to have an independent disconnect.
3. The drive output shall be controlled by the factory installed main unit control system and drive status and operating speed shall be monitored and displayed at the main unit control panel. The supply and return/exhaust fan drive outputs shall be independently controlled in order to provide the control needed to maintain building pressure control. Supply and return/exhaust air fan drives that are slaved off a common control output are not acceptable.
4. All drives shall be factory run tested prior to unit shipment.

G. ELECTRICAL

1. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with unit shall be number and color coded and labeled according to the electrical diagram provided for easy identification.
2. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have

a power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch circuit short circuit protection, 115 volt control circuit transformer and fuse, system switches, and a high temperature sensor. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply and return fan motors shall have contactors and external overload protection. Knockouts shall be provided in the of the main control panels for field wiring entrance.

3. All 115-600 volt internal and external wiring between control boxes and components shall be protected from damage by raceways or liquid tight conduit.
4. The receptacle shall be powered by a field supplied 115V source.
5. Single fused disconnect switch shall be provided for connecting electrical power at the unit. Disconnect switches shall be mounted internal to the control panel and operated by an externally mounted handle. Externally mounted handle is designed to prohibit opening of the control panel door without the use of a service tool.
6. Unit SCCR rating to be 65 kAIC.
7. Phase failure and under voltage protection shall be provided to prevent damage from single phasing, phase reversal, and low voltage conditions.

H. COOLING AND HEATING SECTIONS

1. The cooling coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with factory piped cooling coil and sloped drain pan. Hinged access doors on both sides of the section shall provide convenient access to the coil and drain pan for inspection and cleaning.
2. Direct expansion (DX) cooling coils shall be fabricated of seamless 1/2" diameter high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design. All units shall have a minimum of two independent refrigerant circuits and shall use an interlaced coil circuiting that keeps the full coil face active at all load conditions.
3. Hot water coils shall be Type W and factory mounted in the rooftop unit to provide complete drainage of coil. Hot water modulating valve with actuator shall be provided. Coils shall be sized and be a staggered-tube design, with fin density and size per drawings.
4. Submittals must demonstrate that scheduled unit leaving air temperature (LAT) is met, that fan and motor heat temperature rise (TR) have been considered, and scheduled entering air temperature (EAT) equals mixed air temperature (MAT). Draw-thru cooling - Scheduled EAT equals cooling coil EAT and scheduled unit LAT equals cooling coil LAT plus TR.
5. All coils shall be factory leak tested with high pressure air under water.
6. Coil face areas indicated on the equipment schedule are the minimum acceptable.
7. A stainless steel, positively sloped drain pan shall be provided with the coil. The drain pan shall extend beyond the leaving side of the cooling coil and underneath the coil connections. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall be connected to a threaded drain connection extending through the unit base. Units with stacked coils shall be provided with a secondary drain pan piped to the primary drain pan.

I. FILTERS

1. Unit shall be provided with a draw-through filter section. The filter section shall be supplied complete with the filter rack as an integral part of the unit.
2. Unit shall have two stages of filtration:

    a. Stage 1: include 2-inch thick, pleated panel filters with MERV 8 rating upstream of the cooling coil.
    b. Stage 2: include 4-inch thick, pleated panel filters with MERV 13 rating upstream

of the cooling coil.

3. The filter rack shall have secondary gasketed, hinged end panels to insure proper sealing. Filters shall be accessible from both sides of the filter section.

J. OUTDOOR/RETURN AIR SECTION

1. Unit shall be provided with an outdoor air economizer section. The 0 to 100% outside air economizer section shall include outdoor, return, and exhaust air dampers. Outdoor air shall enter from both sides of the economizer section through horizontal, louvered intake panels complete with rain lip and bird screen. The floor of the outdoor air intakes shall provide for water drainage. The economizer section shall allow return air to enter from the back of the unit. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be opposed sets of parallel blades, arranged vertically to converge the return air and outdoor air streams in multiple, circular mixing patterns.
2. Low leak dampers shall be provided on outdoor or return dampers. Damper blades shall be fully gasketed and side sealed and arranged horizontally in the hood. Damper leakage shall be less than1.5 CFM/Sq. Ft. of damper area at 1.0 inch static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers.
3. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of foreign materials. Exhaust damper blades shall be lined with urethane gasketing on contact edges.
4. Control of the outdoor or return dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating, spring return type. If outdoor air is suitable for “free” cooling, the outdoor air dampers shall modulate in response to the unit’s temperature control system. An adjustable enthalpy control shall be provided to sense the dry-bulb temperature and relative humidity of the outdoor air stream to determine if outdoor air is suitable for “free” cooling
5. Economizer assembly shall be California Title 24 compliant. MicroTech III controls shall display a warning, and write a warning to the BAS, if the economizer malfunctions in accordance with Title 24 specifications.
6. The manufacturer precision ventilation system shall be provided as an integral part of the economizer system. It shall directly measure the total mass volume of air flowing through the outside air intakes. The unit’s control panel shall automatically adjust the outdoor damper position to maintain minimum outdoor air cfm. The airflow station shall be capable of accurately measuring minimum outdoor air volume within 5% to continuously satisfy the requirements of ASHRAE 62-1999. Third party verification of measurement accuracy shall be verified by a nationally recognized independent testing agency.

K. DISCHARGE AND RETURN PLENUM OPTIONS

1. A supply air discharge plenum shall be provided. The plenum section shall have a discharge opening.

L. CONDENSING SECTION

1. Air Cooled Condenser

a. The condensing section shall be open on the sides and bottom to provide access and to allow airflow through the coils. Condenser coils shall be multi-row and fabricated from cast aluminum micro-channel coils. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils are to be recessed so that the cabinet provides built in hail protection.
b. Condenser fans shall be direct drive, propeller type designed for low tip speed,

vertical air discharge, and include service guards. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, inherently protected, three-phase, non-reversing type with permanently lubricated ball bearing and integral rain shield.

c. Units shall have at least one condenser fan controlled to maintain positive head pressure.

2. Scroll Compressors

a. Each unit shall have multiple, heavy-duty Copeland scroll compressors.

b. Each compressor shall be complete with gauge ports, crankcase heater, sight-glass, anti-slug protection, motor overload protection and a 5 minute time anti-cycling time delay.

c. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission.

3. Refrigeration Circuit

a. Each unit shall have two independent refrigeration circuits. Each circuit shall be complete with low pressure control, pump-down switch, liquid line solenoid valve, filter drier, liquid moisture indicator/sight- glass, thermal expansion valve, liquid line charging valve with a 3/8" charging port, a manual reset high pressure safety switch. The thermal expansion valve shall be capable of modulation from 100% to 25% of its rated capacity. Sight-glasses shall be accessible for viewing without disrupting unit operation. Each circuit shall be dehydrated and factory charged with 410-A Refrigerant and oil. Unit shall have discharge and suction line shutoff valves.

b. Each compressor shall be complete with gauge, ports, crankcase heater, sight - glass, anti-slug protection, motor overload protection and a 5 minute time anti-cycling time delay.

4. Hot gas bypass control shall be factory installed on one refrigerant circuits. Hot gas bypass control shall include a modulating hot gas bypass control valve, integral solenoid valve, all associated piping and be automatically operated by the units microprocessor control

M. ROOF CURBS

1. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

2. 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 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

3. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

a. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1) Materials: ASTM C1071, Type I or II.

2) Thickness: 1 inch (25 mm).

b. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

1) Liner Adhesive: Comply with ASTM C916, Type I.

2) 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.

3) 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.

4) Liner Adhesive: Comply with ASTM C916, Type I.

4. Curb Dimensions: Height of 14 inches (355 mm).

N. CONTROLS

1. Each unit shall be equipped with a complete microprocessor based control system. The unit control system shall include all required temperature and pressure sensors, input/output boards, main microprocessor and operator interface. All boards shall be individually replaceable for ease of service. All microprocessors, boards, and sensors shall be factory mounted, wired and tested.
2. Supply air fan to be controlled by duct static pressure. Return fan to be controlled via direct building static pressure.
3. The microprocessor shall be a stand-alone DDC controller not dependent on communications with any on- site or remote PC or master control panel. The microprocessor shall maintain existing set points and operate stand alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.
4. The main microprocessor shall support an RS-232 direct connection to a product service tool or a modem. A BACnet® MSTP communications module shall be provided for direct communication into the BAS network.
5. All digital inputs and outputs shall be protected against damage from transients or wrong voltages. Each digital input and digital output shall be equipped with an LED for ease of service. All field wiring shall be terminated at a separate, clearly marked terminal strip.
6. The microprocessor memory shall be protected from all voltage fluctuations as well as any extended power failures. The microprocessor shall support an RS-232 direct connect from an IBM PC or 100% true compatible using MicroTech software. The microprocessor shall maintain existing set points and operate stand alone if the rooftop loses either direct connect or network communications.
7. The microprocessor shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
8. If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include Zone sensor with tenant override switch, or Zone sensor with tenent override switch and heating/cooling set point adjustment.
9. User Interface (UI)

a. The keypad/display character format shall be 20 characters x 4 lines. The character font shall be a 5 x 8 dot matrix. The display shall be a super twist liquid crystal display (LCD) with black characters on yellow background providing high visibility. The display form shall be in plain English coded formats. Lookup tables are not acceptable.
b. The keypad shall be equipped with 8 individual touch-sensitive membrane key switches. All control settings shall be password protected from changes by unauthorized personnel.
c. Both a unit-mounted and remote-mounted UI shall be provided. One remote UI can communicate with up to 8 separate units. Both the unit-mounted and remote-mounted UI are always active. The control contractor is responsible for wiring between the unit and the remote UI. The maximum wiring distance to the remote UI is 2100 feet. The remote UI shall have an 8 line x 30 character display. The remote UI shall be provided with the same “push and roll” navigational tool and have identical functionality to the unit- mounted UI.

10. The display shall provide the following information:

a. Supply, return, outdoor and space air temperature.
b. Duct and building static pressure- the control contractor is responsible for providing and installing sensing tubes.
c. Fan status and airflow verification.
d. Fan VFD speed.
e. Outside air damper position and economizer mode.
f. Cooling, heating and changeover status.
g. Occupied, unoccupied, and dirty filter status.
h. Date and time schedules.
i. Up to 4 current alarms and 8 previous alarms with time and date.

11. The keypad shall provide the following set points as a minimum:

a. Six control modes including off manual, auto, heat/cool, cool only, heat only and fan only.
b. Four occupancy modes including auto, occupied, unoccupied and bypass (tenant override with adjustable duration).
c. Control changeover based on return air temperature, outdoor air temperaute, or space temperature.
d. Primary cooling and heating set point temperature based on supply or space temperature.
e. Night setback and setup space temp.
f. Cooling and heating control differential (or dead band).
g. Cooling and heating supply temperature reset options based on one of the following: Return air temperature, outdoor air temperature, space temperature, Airflow, or external (1-5VDC) signal.
h. Reset schedule temperature.
i. High supply, low supply and high return air temperature alarm limits.
j. Ambient compressor and heat lockout temperatures.
k. Auto or manual lead lag method on compressors.
l. Compressor interstage timers duration.
m. Duct and Building static pressure
n. Minimum outdoor airflow reset based on external reset (1-5 VDC), percent of CFM capacity, and fixed outdoor damper position.
o. Economizer changeover based on enthalpy, dry bulb or network signal.
p. Current time and date.
q. Occupied/unoccupied time schedules with allowances for holiday/ event dates and duration.

r. Three types of service modes including timers normal (all time delays,) timers fast (all time delays 20 seconds,) and normal.

12. Open Communications Protocol – The unit control system shall have the ability to communicate to an independent Building Management System (BMS) through a direct BACnet MSTP It shall use only standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE 135-2001.) A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided. Multiple units may be connected in a common communications network.
13. The independent BMS system shall have access to “read only’ variables and “read & and write” variables. Communications shall not require field mounting of any additional sensors or devices at the unit. The BMS system shall be capable of interacting with the individual rooftop controllers in the following ways

    a. Monitor controller inputs, outputs, set points, parameters and alarms.
    b. Set controller set points and parameters.
    c. Clear alarms.
    d. Reset the cooling adischarge air temperature set point.
    e. Reset the duct static pressure set point (VAV units).
    f. Set the heat/cool changeover temperature (VAV and CAV-DTC units).
    g. Set the representative zone temperature (CAV-ZTC units).

14. It will be the responsibility of the Systems Integrating Contractor to integrate the rooftop data into the BMS control logic and interface stations.
15. Refrigeration capacity control shall be accomplished by staging of the unit's multiple compressors. Unit shall be equipped with a 120V terminal strip for field supplied and installed controls.
16. Variable Frequency Drive shall provide the following parameters available via BACnet to the BAS:

    a. Speed Feedback
    b. Frequency
    c. Current (amps)
    d. Percent Torque
    e. Power kW
    f. Kilowatt hours
    g. Operating hours
    h. Drive temperature
    i. All warning and fault information

O. WARRANTY

1. The manufacturer shall provide 12 month parts only warranty. Defective parts will be repaired or replaced during the warranty period at no charge. The warranty period shall commence at start up, or 6 months after shipment, which ever occurs first.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, maintaining manufacturer's recommended clearances. Install in conformance with ARI Guideline B.

B. Curb Support: Install roof curb on roof structure, level and secure, according to ARI Guideline B. Install and secure rooftop air conditioners on curbs and coordinate roof penetrations and flashing with roof construction.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination in roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to rooftop unit with flexible duct connectors specified in DUCT ACCESSORIES Section.
4. Terminate return-air duct through roof structure and insulate space between roof and bottom of unit with 2-inch- thick, acoustic duct liner.
5. Install normal-weight, 3000 psi, compressive strength (28-day) concrete mix inside roof curb, 4 inches thick. Concrete, formwork, and reinforcement are specified in Division 03.

D. Electrical System Connections: Comply with applicable requirements in Division 16 Sections for power wiring, switches, and MOTOR CONTROLS Section.

E. Ground equipment in conformance with GROUNDING AND BONDING Section.

F. 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 and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field quality-control tests and inspections and prepare test reports:

1. After installing rooftop air conditioners 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.

C. Remove malfunctioning units, replace with new units, and retest as specified above.

3.4 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. 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 two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain rooftop air conditioners.

END OF SECTION 23 74 00

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SECTION 23 81 23

DUCTLESS 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:

1. Wall mount split system air conditioners.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Electrical & IDF-room air conditioners 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 from the device when subjected to the seismic forces specified."

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For electrical & IDF-room air conditioners. 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.

C. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.

D. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from Installers of the items involved.

E. Seismic Qualification Certificates: For electrical & IDF-room air conditioners, 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.

F. Field quality-control reports.

G. Operation and Maintenance Data: For electrical & IDF-room air conditioners to include in emergency, operation, and maintenance manuals.

H. Warranty: Sample of special warranty.

1.5 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 62.1-2004, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

1.6 COORDINATION

A. Coordinate layout and installation of electrical & IDF-room air conditioners 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.

B. Coordinate installation of electrical & IDF-room air conditioners with electrical & IDF-room access flooring Installer.

C. Coordinate sizes and locations of concrete bases with actual equipment provided.

D. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electrical & IDF-room air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

1.8 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. Fan Belts: One set(s) for each belt-driven fan.

2. Filters: One set(s) of filters for each unit.

PART 2 - PRODUCTS

2.1 DUCTLESS SPLIT SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Daikin

2. Mitsubishi.

3. Toshiba-Carrier.

B. BASIS OF DESIGN: is Daikin. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural, and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculations.

C. Description: Outdoor-mounted, air-cooled split system outdoor section suitable for rooftop installation. Unit shall consist of a hermetic compressor, an air-cooled coil, propeller-type condenser fan, and a control box. Unit shall discharge air horizontally as shown on the contract drawings. Units shall function as the outdoor component of an air-to air cooling system.

D. Standard Features

1. Unit will be rated in accordance with the latest edition of ARI Standard 210.

2. Unit will be certified for capacity and efficiency, and listed in the latest ARI directory.

3. Unit construction will comply with latest edition of ANSI/ASHRAE and with NEC.

4. Unit will be constructed in accordance with UL standards and will carry the UL label of approval. Unit will have c-UL approval.

5. Unit cabinet shall be capable of withstanding Federal Test Standard No. 141 (method 6061) 500-hour salt spray test.

6. Air-cooled condenser coils will be leak tested and pressure tested.

7. Unit constructed in ISO9001 approved facility.

8. Unit shall be rated per ARI Standards 210/240 and listed in the ARI directory as a matched system.

E. Delivery, Storage, and Handling: Unit(s) shall be stored and handled per manufacturer's recommendations.

2.2 OUTDOOR CONDENSING UNIT

A. PRODUCTS

1. General: Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, refrigerant charge Puron® (R-454B), and special features required prior to field start-up.

2. Unit Cabinet: Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a powder coat paint.

3. Fans:

   a. Outdoor fans shall be direct-drive propeller type, and shall discharge air horizontally. Fans shall blow air through the outdoor coil.
   b. Outdoor fan motors shall be totally enclosed, single-phase motors with class B insulation and permanently lubricated bearings. Shafts will be corrosion resistant.
   c. Shaft shall have inherent corrosion resistance.
   d. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.
   e. Outdoor fan openings will be equipped with coated steel wire safety guards.

4. Compressor: Compressor will be hermetically sealed rotary type.

   a. Compressor assembly shall be installed on rubber vibration isolators.
   b. Compressors shall be single-phase as specified on the contract drawings.

5. Outdoor Coil:

   a. Coil shall be constructed of aluminum fins mechanically bonded to internally enhanced, seamless copper tubes, which are cleaned, dehydrated, and sealed.
   b. Apply Luvata® Insitu, or equal, protective coating. Shall be a spray-applied, low VOC, synthetic, water-based coating embedded with 316 stainless steel to all coil surface areas, Coating shall be flexible when cured and have a dry film thickness of 1.-2. mils of thickness and resistant to cracking due to thermodynamic expansion and contraction.
   c. Coating shall be compliant with EPA standards and registered with the SCAQMD as an environmentally sustainable single part water based coating, registered and permitted with local EPA air management agencies for use as a HVAC protective coating product.

d. Application company shall be fully permitted, licensed and can demonstrate an association with United Technologies Corporation for a period longer than 5 years and show a history of workmanship compliance excellence with the manufacture of such equipment specified.
e. Coating applicator shall prove to be in business and financially solvent for a period exceeding the specified warranty of 5 years.
f. Coating shall have superior hardness characteristics per ASTM D3363-92A and a crosshatch adhesion of 4B-5B per ASTM B3359-93. Humidity and water immersion resistance shall be up to a minimum of 1000 hours (ASTM D2247).
g. Polymer coating will meet ASTM requirements in relation to microbial contamination as per G-21 and D-3273 testing protocol.
h. Corrosion durability shall be confirmed through testing of no less than 5,000 hours salt spray per ASTM B117-90.
i. 5-year written and submitted conditional warranties mandatory for project.

6. Refrigeration Components:

   a. Refrigeration circuit components will include liquid-line front-seating shut-off valve with sweat connections, vapor-line front seating shutoff valve with sweat connections, accumulator, system charge of Puron® (R-454B) refrigerant, and compressor oil.
   b. Unit will be equipped with high-pressure switch, low pressure switch and filter drier for Puron refrigerant.

7. Controls and Safeties:

   a. Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:

8. Controls:

   a. Time delay restart to prevent compressor reverse rotation on single-phase scroll compressors.
   b. Automatic restart on power failure.
   c. Safety lockout if any outdoor unit safety is open.
   d. A time delay control sequence provided through the fan coil board, thermostat, or controller.
   e. Liquid line low-pressure switches.
   f. Automatic outdoor-fan motor protection.

9. Safeties:

   a. System diagnostics.
   b. Compressor motor current and temperature overload protection.
   c. High-pressure relief.
   d. Outdoor fan failure protection.

10. Electrical Requirements:

    a. Units shall operate on single-phase, 60-cycle power at 115V for sizes 009-012 and 208/230V for sizes 012,018, and 024 as specified.
    b. Unit electrical power shall be a single point connection.

c. All power and control wiring must be installed per NEC and all local building codes.

11. Special Features (Field Installed):

a. Low-Ambient Kit: Control shall regulate fan-motor cycles in response to saturated condensing, pressure of the unit. The control shall be capable of maintaining a condensing temperature of 100 F with outdoor temperatures to –20 F. Installation of kit shall not require changing the outdoor-fan motor.
b. Crankcase Heater: An electric resistance heater which mounts to the base of the compressor to keep the lubricant warm during off cycles. A crankcase heater is required for low ambient operation.

2.3 DUCTLESS HIGH-WALL MOUNTED FAN COIL

A. SYSTEM DESCRIPTION: Indoor, wall-mounted, direct-expansion fan coil matched with a cooling only outdoor unit. Unit sizes 3 / 4 to 2 tons. Carrier model RAV (cooling only).

B. STANDARD FEATURES: Unit shall be rated per ARI Standards 210/240 and listed in the ARI directory as a matched system.

C. DELIVERY, STORAGE, AND HANDLING: Unit(s) shall be stored and handled per manufacturer's recommendations.

D. PRODUCTS

1. GENERAL: Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with cooling/heating coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall mounting bracket and mounting hardware.

E. UNIT CABINET: Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.

F. Fans: Fan shall be tangential direct-drive blower type with air intake at the top of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard. Air sweep operation shall be user selectable. The vertical sweep may be adjusted (using the remote control) and the horizontal air direction may be set manually.

G. Coil: Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap.

H. Motor: overload protection. Fan motors shall be 3-speed.

I. Controls: Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self-

diagnostics. The temperature control range shall be from 62 deg F to 84 deg F. The unit shall have the following functions as a minimum:

1. An automatic restart after power failure at the same operating conditions as at failure.

2. A timer function to provide a minimum 24-hour timer cycle for system Auto Start/Stop.

3. Indoor coil freeze protection.

4. Wireless infrared remote control to enter set points and operating conditions.

5. Automatic air sweep control to provide on or off activation of air sweep louvers.

6. Fan-only operation to provide room air circulation when no cooling is required.

7. Fan speed control shall be user-selectable: high, medium, low, or microprocessor controlled automatic operation during all operating modes.

J. Filters: Unit shall have filter track with factory-supplied cleanable filters.

K. Refrigerant Lines: All units should have refrigerant lines that can be oriented to connect from the left, right or back of the unit. Both refrigerant lines need to be insulated.

L. Power Requirements: Unit main power is supplied to the outdoor unit. Contractor shall supply 4-wire connecting cable to supply power to the indoor unit. For 9K and 12K units, all four wires are low voltage DC. For 18K and 24K units, two wires are high voltage AC power, one is low voltage DC, and one is ground wire.

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 roughing-in for DX piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where electrical & IDF-room air conditioners will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping." Provide shutoff valves and piping.

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:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.

2. After installing electrical & IDF-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.

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.

D. Electrical & IDF-room air conditioners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. After startup service and performance test, change filters.

3.4 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. 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 two visits to Project during other-than-normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain electrical & IDF-room air conditioners.

END OF SECTION

SECTION 23 81 23.13

COMPUTER-ROOM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

Section includes ceiling-mounted, computer-room air conditioners.

1.3 DEFINITIONS

COP: Coefficient of performance.

A. EER: Energy efficiency ratio.

B. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS

Product Data: For each type of product.

Include material descriptions, dimensions of individual components and profiles, and finishes for computer-room air-conditioning units.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

Sustainable Design Submittals:

Product Data: For energy performance.

2. Product Data for EA Prerequisite "Fundamental Refrigerant Management": For refrigerants, indicating compliance with refrigerant management practices.

3. Product data showing compliance with ASHRAE 62.1.

Shop Drawings: For computer-room air conditioners.

Include plans, elevations, sections, and attachment details.

4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

5. Include diagrams for power, signal, and control wiring.

Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers of the items involved.

A. Seismic Qualification Certificates: For computer-room air conditioners, accessories, and components, from manufacturer.

Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

1. Dimensioned Outline Drawings of Equipment Unit: 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.

Field quality-control reports.

B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Two set of filters for each unit.

1.8 WARRANTY

Special Warranty: Manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.

Warranty Period for Compressors: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

1. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Liebert; a brand of Emerson Electric Co.
2. APC by Schneider Electric.
3. Compu-Aire, Inc.
4. Data Aire Inc.
5. Stulz-ATS.

BASIS OF DESIGN: is Liebert. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to reviewing submittals to establish acceptability and updating energy compliance calculation.

2.2 PERFORMANCE REQUIREMENTS

Seismic Performance: Computer-room air-conditioners, ceiling-mounted units shall withstand the effects of earthquake motions determined according to ASCE.

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.

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.

A. ASHRAE Compliance:

Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

1. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

B. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

2.3 MANUFACTURED UNITS

Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls.

1. Mounting Configuration: Concealed above a lay-in ceiling.

Cabinet: Galvanized steel serviceable from one side, with baked-enamel finish, insulated with 1/2-inch thick duct liner, and mounting bracket attached to the unit.

2. Unit with supply and return collars for ducting in the field.

3. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Supply-Air Fan:

4. Plug/plenum, single inlet, direct drive, electronically commutated, and variable speed.

Refrigeration System:

Compressor: Scroll, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.

5. Refrigeration Circuit Components:

Low-pressure switch.
a. Manually reset, high-pressure switch.
b. Thermal-expansion valve with external equalizer.
c. Sight glass with moisture indicator.
d. Service shutoff valves.
e. Charging valves.
f. Hot-gas bypass.
g. Refrigerant charge.

Refrigerant: R-32.

6. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.

7. Refrigerant line-sweat-adapter kit to permit field brazing of refrigerant lines.

Mount stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir under coil assembly.

Remote, Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with

direct-drive, propeller fan.

8. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

Filter: 4-inch-thick, disposable, pleated-type.

Filter Minimum Efficiency Reporting Value:

MERV Rating: MERV-8 according to ASHRAE 52.2.

Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

B. Single point power kit permitting single electrical feed to the evaporator and condensing unit of a close-coupled system.

C. Control System:

Microprocessor remote-mounted panel.

1. Fan contactor.
2. Compressor contactor.
3. Compressor start capacitor.
4. Control transformer with circuit breaker.
5. Solid-state temperature-control modules.
6. Time-delay relay.
7. Heating contactor.
8. Smoke sensor.
9. Filter clog switch.
10. Alarm contacts.
11. High-temperature thermostat.
12. Solid-state, wall-mounted control panel with start-stop switch and adjustable temperature set point.
13. Remote panel to monitor and change temperature and humidity set points and sensitivities of the unit and unit alarms.

Fan Motors:

Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.

a. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for

installation tolerances and other conditions affecting performance of the Work.

A. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

B. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

Layout and install computer-room air conditioners and suspension system coordinated with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

A. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances.

B. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and spring hangers of size required to support weight of computer-room air conditioner.

Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC." Fabricate brackets or supports as required.

1. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

Air-Cooled Refrigerant Condenser Mounting: Install using elastomeric pads on leveled platform. Comply with requirements for vibration isolation devices specified in [Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 CONNECTIONS

Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

A. Where installing piping adjacent to computer-room air conditioners, allow space for service and maintenance.

B. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Provide shutoff valves and piping.

3.4 FIELD QUALITY CONTROL

Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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:

Inspect for and remove shipping bolts, blocks, and tie-down straps.

1. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.

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.

Computer-room air conditioners will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

D. After startup service and performance test, change filters and flush humidifier.

3.5 ADJUSTING

Adjust initial temperature set points.

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. 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 two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

Train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION

SECTION 23 81 26

SPLIT SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Split System Air Conditioners consists of furnishing transportation, labor, materials, and equipment to furnish and install split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting and may be connected to ducts.

1.2 REFERENCES

A. ARI

B. ASHRAE

C. National Fire Protection Association (NFPA)

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

F. California Title 24 Acceptance Testing, completed for each system by HVAC subcontractor or balance subcontractor.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated.

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. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Unit shall be rated per ARI Standards 210/240 and listed in the ARI Directory as a matched system.

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in CAST-IN-PLACE CONCRETE Section.

B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in ROOF ACCESSORIES Section.

1.6 WARRANTY

A. Warranty Period: Five years from date of Substantial Completion.

1.7 SYSTEM STARTUP

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Daikin

2. Mitsubishi.

3. Carrier.

B. BASIS OF DESIGN: is Daikin. If contractor submits on listed alternates, he shall assume monetary and logistical responsibility for any and all necessary structural, electrical, plumbing, architectural, and HVAC modifications. Contractor shall also compensate the Architect of Record (AOR) and Mechanical Engineer of Record (MEOR) for efforts related to updating energy compliance calculations

2.2 OUTDOOR MOUNTED HEAT PUMP CONDENSING UNIT

A. System Description: Outdoor-mounted, air-cooled split system outdoor heat pump section suitable for on-the-ground or rooftop installation. Unit shall consist of a hermetic scroll compressor, an air-cooled coil, propeller-type condenser fan, and a control box. Unit shall discharge air vertically as shown on the contract drawings. Units shall function as the outdoor component of an air-to air cooling system.

B. Standard Features:

1. Unit will be rated in accordance with the latest edition of ARI Standard 210.
2. Unit will be certified for capacity and efficiency, and listed in the latest ARI directory.
3. Unit construction will comply with latest edition of ANSI/ASHRAE and with NEC.
4. Unit will be constructed in accordance with UL standards and will carry the UL label of approval. Unit will have c-UL approval.
5. Unit cabinet shall be capable of withstanding Federal Test Standard No. 141 (method 6061) 500-hour salt spray test.
6. Air-cooled condenser coils will be leak tested and pressure tested.
7. Unit constructed in ISO9001 approved facility.
8. Unit shall be rated per ARI Standards 210/240 and listed in the ARI directory as a matched system.

C. Delivery, storage, and handling

1. Unit(s) shall be stored and handled per manufacturer's recommendations.

2.3 PRODUCTS

A. GENERAL: Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, refrigerant charge, and special features required prior to field start-up.

B. Unit Cabinet:

1. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a powder coat paint.

C. Fans:

1. Outdoor fans shall be direct-drive propeller type, and shall discharge air vertically. Fans shall draw air through the outdoor coil.
2. Outdoor fan motors shall be totally enclosed, single-phase motors with class B insulation and permanently lubricated bearings. Shafts will be corrosion resistant.
3. Shaft shall have inherent corrosion resistance.
4. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.
5. Outdoor fan openings will be equipped with coated steel wire safety guards.

D. Compressor:

1. Compressor will be hermetically sealed.
2. Compressor assembly shall be installed on rubber vibration isolators.
3. Compressors shall be single-phase or 3-phase as specified on the contract drawings.

E. Outdoor Coil:

1. Coil shall be constructed of aluminum fins mechanically bonded to internally

enhanced, seamless copper tubes, which are cleaned, dehydrated, and sealed.

2. Apply Luvata® Insitu, or equal, protective coating. Shall be a spray-applied, low VOC, synthetic, water-based coating embedded with 316 stainless steel to all coil surface areas, Coating shall be flexible when cured and have a dry film thickness of 1.-2. mils of thickness and resistant to cracking due to thermodynamic expansion and contraction.
3. Coating shall be compliant with EPA standards and environmentally sustainable single part water based coating, registered and permitted with local EPA air management agencies for use as a HVAC protective coating product.
4. Application company shall be fully permitted, licensed and can demonstrate an association with United Technologies Corporation for a period longer that 5 years and show a history of workmanship compliance excellence with the manufacture of such equipment specified.
5. Coating applicator shall prove to be in business and financially solvent for a period exceeding the specified warranty of 5 years.
6. Coating shall have superior hardness characteristics per ASTM D3363-92A and a crosshatch adhesion of 4B-5B per ASTM B3359-93. Humidity and water immersion resistance shall be up to a minimum of 1000 hours (ASTM D2247).
7. Polymer coating will meet ASTM requirements in relation to microbial contamination as per G-21 and D-3273 testing protocol.
8. Corrosion durability shall be confirmed through testing of no less than 5,000 hours salt spray per ASTM B117-90.
9. 5-year written and submitted conditional warranties mandatory for project.

F. Refrigeration Components:

1. Refrigeration circuit components will include liquid-line front-seating shut-off valve with sweat connections, accumulator, vapor-line front seating shutoff valve with sweat connections, holding charge of R-454B refrigerant, and compressor oil.
2. Unit will be equipped with high-pressure switch, low pressure switch and filter drier for refrigerant.
3. Contractor to add additional refrigerant as required to fully charge the system.

G. Controls and Safeties: Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:

1. Controls:

   a. Time delay restart to prevent compressor reverse rotation on single-phase scroll compressors.
   b. Automatic restart on power failure.
   c. Safety lockout if any outdoor unit safety is open.
   d. A time delay control sequence provided through the fan coil board, thermostat, or controller.
   e. Liquid line low-pressure switches.
   f. Automatic outdoor-fan motor protection.

2. Safeties:

   a. System diagnostics.

b. Compressor motor current and temperature overload protection.
c. High-pressure relief.
d. Outdoor fan failure protection.

H. Electrical Requirements:

1. Units shall operate on single-phase, 60-cycle power at 208/230V.
2. Unit electrical power shall be a single point connection.
3. All power and control wiring must be installed per NEC and all local building codes.

I. Special Features (Field Installed):

1. Low-Ambient Kit:

a. Control shall regulate fan-motor cycles in response to saturated condensing, pressure of the unit. The control shall be capable of maintaining a condensing temperature of 100 F ± 10 F with outdoor temperatures to –20 F. Installation of kit shall not require changing the outdoor-fan motor.

2. Crankcase Heater:

a. An electric resistance heater which mounts to the base of the compressor to keep the lubricant warm during off cycles. A crankcase heater is required for low ambient operation.

2.4 DIRECT EXPANSION FAN COIL

A. System Description

1. Indoor-mounted fan coil unit for use in commercial split system heat pumps. Unit shall be capable of horizontal, up-flow, or down-flow installation. Voltage shall be 208/230-1-60. Supply with R-454B direct-expansion evaporator coil for use with a matching outdoor heat pump condensing unit.

B. Quality Assurance

1. Coils shall be designed and tested in accordance with ASHRAE 15 Safety Code for Mechanical Refrigeration, latest addition. The fan coil shall have a UL label of approval.

C. Delivery, Storage and Handling

1. Units shall be stored and handled per manufacturer's instructions.

D. Warranty

1. All parts shall have 5-year warranty.

2.5 PRODUCTS AND EQUIPMENT

A. Indoor-mounted, draw-thru, fan coil unit consisting of a forward curved direct-drive fan, fan motor, pre-wired fan motor contactor, cooling coil, and PVC condensate pan. Include factory R-454B thermal expansion valve.

B. Provide copper tube aluminum fin evaporator coil with piston-type refrigerant metering device. Leak test coil at 150 psi and burst test at 435 psi. Suction and liquid line piping connections and condensate piping connections shall be made on the same side of the coil.

C. Provide cabinet of made of pre-painted galvanized steel. Provide knockouts for primary power and control power wiring. Disconnect shall be by the electrical contractor.

D. Unit shall be capable of providing the scheduled cfm at the scheduled external static pressure.

E. Install the fan coil per plans and specifications. Fan coil suspension hangers, isolation, platforms, condensate pumps, or auxiliary condensate pans shall furnished and installed by mechanical contractor.

F. Provide super high efficiency ECM direct drive fan motor.

G. Cabinet shall be insulated with R-4.2 insulation with vapor barrier. Cabinet shall not leak more than 2 percent when tested at 1.0 inches static pressure.

H. Provide 2” filter rack with MERV 13 filters.

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 ground mounting, compressor-condenser components on 6inch- thick, reinforced concrete base; 6 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified on drawings. Coordinate anchor installation with concrete base.

D. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

E. Outdoor unit to be mounted on 3/4" neoprene waffle pads equal to Mason Industries SW with isolated bolting via neoprene washer/bushing elements equal to Mason Industries HG.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings

indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Duct Connections: Duct installation requirements are specified in METAL DUCTS Section. Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in DUCT ACCESSORIES Section.

D. Ground equipment in conformance with GROUNDING AND BONDING Section.

E. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

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.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Department maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

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SECTION 26 00 00

GENERAL ELECTRICAL SPECIFICATIONS (rev 09-18)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This specification shall apply to all phases of Work hereinafter specified, shown on Drawings, or as required to provide a complete installation of electrical systems for this Project. Work required under this specification is not limited to just the Electrical Drawings - refer to Architectural, Structural, Landscape, and Mechanical/Plumbing Drawings, as well as all other drawings applicable to this project, which designate the scope of work to be accomplished. The intent of the Drawings and Specifications is to provide a complete and operable electrical system that includes all documents that are a part of the Contract.

1. Work Included: Furnish labor, material, services and skilled supervision necessary for the construction, erection, installation, connections, testing, and adjustment of all circuits and electrical equipment specified herein, or shown or noted on Drawings, and its delivery to the Owner complete in all respects ready for use.
2. The electrical Work includes installation or connection of certain materials and equipment furnished by others. Verify installation details, installation and rough-in locations from the actual equipment or from the equipment shop drawings.

B. Electrical Drawings: Electrical Drawings are diagrammatic, and are intended to convey the scope of work, indicating intended general arrangement of equipment, conduit and outlets. Follow Drawings in laying out Work and verify spaces for installation of materials and equipment based on actual dimensions of equipment furnished.

1.2 QUALITY ASSURANCE

A. Design, manufacture, testing and method of installation of all apparatus and materials furnished under requirements of these specifications shall conform to latest publications or standard rules of the following:

1. Institute of Electrical and Electronic Engineers - IEEE
2. National Electrical Manufacturers' Association - NEMA
3. Underwriters' Laboratories, Inc. - UL
4. National Fire Protection Association - NFPA
5. Federal Specifications - Fed. Spec.
6. American Society for Testing and Materials - ASTM
7. American National Standards Institute - ANSI
8. National Electrical Code - NEC
9. National Electrical Safety Code - NESC
10. Insulated Cable Engineers Association - ICEA
11. American Institute of Steel Construction - AISC
12. State and Municipal Codes In Force In The Specific Project Area
13. Occupational Safety and Health Administration (OSHA)
14. Electronics Industries Association/Telecommunications Industry Association (EIA/TIA)
15. California Electrical Code (where adopted)
16. Local Authority Having Jurisdiction (AHJ) Published Electrical Standards and Codes

B. Perform Work in accordance with the National Electrical Code, applicable building ordinances, and other applicable codes, hereinafter referred to as the "Code." The Contractor shall comply with the Code including local amendments and interpretations without added cost to the Owner. Where Contract Documents exceed minimum requirements, the Contract Documents take precedence. Where code conflicts occur, the most stringent shall apply unless variance is approved.

1. Comply with all requirements for permits, licenses, fees and codes. The Contractor, at Contractor's expense, shall obtain all permits, licenses, fees, special service costs, inspections and arrangements required for Work under this contract, unless otherwise specified.
2. Comply with requirements of the applicable utility companies serving this Project. Make all arrangements with utility companies for proper coordination of Work.

1.3 GENERAL REQUIREMENTS

A. Guarantee: Furnish a written guarantee for a period of (1) one-year from date of acceptance.

B. Wherever a discrepancy in quantity or size of conduit, wire, equipment, devices, circuit breakers, etc., (all materials), arises on the Drawing and/or Specifications, the Contractor shall be responsible for providing and installing all material and services required by the strictest condition noted on Drawings and/or in Specifications to ensure complete and operable systems as required by the Owner and Engineer.

C. All Core Cutting, Drilling, and Patching:

1. For the installation of work under this Section, the aforementioned shall be performed under this Section of the Specifications and the Concrete section of the Specifications.
2. No holes will be allowed in any structural members without the written approval of the Project's Structural Engineer.
3. For penetrations of concrete slabs or concrete footings, the work shall be as directed in the Concrete Section of Specifications.
4. The Contractor shall be responsible for patching and repairing surfaces where he is required to penetrate for work under this contract.
5. Penetrations shall be sealed to meet the rated integrity of the surface required to be patched and repaired. The patched surface shall be painted or finished to match the existing surface.

D. Verifying Drawings and Job Conditions:

1. The Contractor shall examine all Drawings and Specifications in a manner to be fully cognizant of all work required under this Section.
2. The Contractor shall visit the site and verify existing conditions. Where existing conditions differ from Drawings, adjustment(s) shall be made and allowances included for all necessary equipment to complete all parts of the Drawings and Specifications.

1.4 WORK IN COOPERATION WITH OTHER TRADES

A. Examine the Drawings and Specifications and determine the work to be performed by the electrical, mechanical and other trades. Provide the type and amount of electrical materials and equipment necessary to place this work in proper operation, completely wired, tested and ready for use. This shall include all conduit, wire, disconnects, relays, and other devices for the required operation sequence of all electrical, mechanical and other systems or equipment.

B. Provide a conduit-only system for low voltage wiring required for control of mechanical and plumbing equipment described in this or other parts of the Contract Documents. Install all control housings, conduits, and backboxes required for installing conductors to the controls.

C. Install separate conduits between each heating, ventilating and air conditioning sensing device and its control panel and/or control motor. Before installing any conduit for heating, ventilating and air conditioning control wiring, verify the exact requirements from the control diagrams provided with the equipment manufacturer's shop drawings.

1.5 TESTING AND ADJUSTMENT

A. Upon completion of all electrical work, the Contractor shall test all circuits, switches, light fixtures, lighting control and dimming systems including distributed systems, UPSs, generators, SPDs, lighting inverters, transfer switches, motors, circuit breakers, motor starters and their auxiliary circuits and any other electrical items to ensure perfect operation of all electrical equipment.

B. Equipment and parts in need of correction and discovered during such testing, shall be immediately repaired or replaced with all new equipment and that part of the system shall then be retested. All such replacement or repair shall be done at no additional cost to the Owner.

C. All circuit(s) shall be tested for continuity and circuit integrity. Adjustments shall be made for circuits not complying with testing criteria.

D. All test reports, including copies of any required Energy Code Acceptance Forms (e.g. CA Title 24 Acceptance for Code Compliance Forms) should be submitted to the Engineer at completion of project.

1.6 IDENTIFICATION

A. Nameplates shall be provided for unit substations, switchgear, switchboards, distribution boards, distribution panels, panel boards, motor control centers, transformers, transfer switches, contactors, starters, disconnect switches, enclosed circuit breakers/switches, inverters, UPSs, PDUs, RDCs, SPDs, lighting control panels, dimming panels, door releasing system panels, fire alarm/central monitoring terminal cabinets/power supplies/control panels, and all low voltage system terminal and control cabinets.

1. Nameplate inscriptions shall be identical to the equipment designations indicated in plans and specifications. Nameplates shall be engraved with the device designation/identification on the top line, source identification for the device on the 2nd line per NEC, or CEC where adopted, Art 408.4 and load designation for the device on the bottom line. Where load designation consists of a branch circuit, omit bottom line. Where device designation is not indicated on plans/specifications, Contractor shall submit a written clarification request to the Engineer.
2. Example: Transformer 1TA
   a. Source Disconnecting Location: Switchboard MSA located in Rm 110
   b. Load: Panels 1LA and 1 LB

3. All circuit breakers/fuses in switchgear, switchboards, distribution boards, distribution panels, UPS output circuit breakers, PDU sub-feed circuit breakers and motor control centers shall have individual nameplates located immediately adjacent to the respective device. Nameplate inscription shall identify the downstream equipment or device served by the circuit breaker or fuse.

B. Identification nameplates, UON, shall be laminated/extruded modified acrylic that is 3/32" thick, UV-stabilized, matte finish, suitable for use in 180 deg. F ambient, with beveled edges and engraved white letters 3/8" high, minimum, on 1-1/2" high black background (utility/normal and optional standby power systems) for single line of text. Where two lines of text are required, provide minimum 2" high nameplate. Where three lines of text are required, provide minimum 2.5" high nameplate. Provide white letters on red background for all NEC, or CEC where adopted, Article 517 essential power systems, Article 700 Emergency Systems, Article 701 Legally required standby systems and Article 708 COPS.

C. Identification nameplates for new switchgear, switchboards, distribution boards, distribution panels, panel boards and motor control centers shall be attached with switchgear manufacturer-provided screws via switchgear manufacturer factory pre-drilled holes. A factory option to rivet identification nameplates to the equipment is only acceptable if screw-fastened nameplates are not an available option from the switchgear manufacturer. Field drilling or other mechanical attachment methods that change/void the NEMA or NTRL rating of the enclosure are strictly forbidden.

D. Identification nameplates for transformers, transfer switches, disconnect switches, enclosed circuit breakers/switches, inverters, UPSs, PDUs, RDCs, SPDs, lighting control panels, dimming panels, door releasing system panels, terminal cabinets and all circuit breakers/fuses in switchgear, switchboards, distribution boards, distribution panels, UPS output circuit breakers, PDUs, PDU sub-feed circuit breakers, and motor control centers shall be attached to the equipment by self-adhesive backing integral to the nameplates. When equipment is located outdoors, provide nameplates without self-adhesive backing and attach to equipment using weather-rated, UV-resistant epoxy. In all cases, clean surfaces before applying identification nameplates parallel to equipment lines.

E. Warning Placards, as required by General Single Line Diagram Notes for multiple power sources, or instruction placards, as required for all kirk-key interlock schemes, all UPS bypass procedures or as required elsewhere in the plans/specifications shall be engraved 1/2" high white lettering on a red background using the same material specified for identification nameplates with a self-adhesive backing. Warning/instruction placards shall be attached to the face of the equipment directly related to the placards. Provide a formal placard submittal for review by the Engineer prior to ordering any warning/instruction placards. In all cases, clean surfaces before applying warning/instruction placards parallel to equipment lines.

F. Receptacles that are part of a UL-listed under floor computer room whip assembly, ceiling and/or cable/ladder tray-mounted receptacles used in lab, manufacturing, commercial kitchen environments or that are serving telecom/data/AV racks and cabinets shall have identification nameplates located on the wiring device plate cover. Nameplates shall be self-adhesive, 3/32" thick Micarta with beveled edges, engraved 1/4" high white lettering on black background with serving power source, circuit identification and NEMA/IEC receptacle type. Use of two (2) separate nameplates per device plate cover is acceptable. Affix nameplates to be visible when plugs are occupying receptacles.

G. See wiring device section of this specification for wiring device plate cover labeling requirements.

H. See drawings for panel board schedule directory installation requirements.

I. See conduit installation section of this specification for conduit labeling requirements.

1.7 FINAL INSPECTION AND ACCEPTANCE

A. After all requirements of the Specifications and/or the Drawings have been fully completed; representatives of the Owner will inspect the work. Contractor shall provide competent personnel to demonstrate the operation of any item or system to the full satisfaction of each representative.

B. Final acceptance of the work will be made by the Owner after receipt of approval and recommendation of acceptance from each representative.

1.8 RECORD DRAWINGS

A. Drawings of Record: The Contractor shall provide and keep up-to-date, a complete record set of drawings. These shall be corrected daily and show every change from the original Drawings. This set of prints shall be kept on the job site and shall be used only as a record set. This shall not be construed as authorization for the Contractor to make changes in the layout without definite instruction in each case. Upon completion of the work, a set of reproducible Contract Drawings shall be obtained from the General Contractor and all changes as noted on the record set of prints shall be incorporated thereon with black ink in a neat, legible, understandable and professional manner. Refer to the Supplementary General Conditions for complete requirements.

1.9 APPROVALS, EQUALS, SUBSTITUTIONS, ALTERNATIVES, NO KNOW EQUAL

A. Approvals: Where the words (or similar terms) “approved”, “approval”, “acceptable”, and “acceptance” are used, it shall be understood that acceptance by the Owner, Architect and Engineer are required.

B. Equal: Where the words (or similar terms) “equal”, “approved equal”, “equal to”, “or equal by”, “or equal” and “equivalent” are used, it shall be understood that these words are followed by the expression “in the opinion of the Owner, Architect, and Engineer.” For the purposes of specifying products, the above words shall indicate the same size, made of the same construction materials, manufactured with equivalent life expectancy, having the same aesthetic appearance/style (includes craftsmanship, physical attributes, color and finish), and the same performance.

C. Substitution: For the purposes of specifying products, “substitution” shall refer to the submittal of a product not explicitly approved by the construction documents/ specifications.

1. Substitutions of specified equipment shall be submitted and received by the Engineer ten (10) days prior to the bid date for review and written approval. Regulatory Agency approval for all substitutions will be the sole responsibility of the Contractor. To receive consideration, requests for substitutions must be accompanied by documentary proof of its equality with the specified material. Documentary proof shall be in letterform and identify the specified values/materials alongside proposed equal values/materials. In addition, catalog brochures and samples, if requested, must be included in the submittal. ONLY PRE-BID APPROVED PRODUCTS, ISSUED VIA A FORMAL BID ADDENDUM TO ALL BIDDERS, WILL BE ALLOWED ON THE PROJECT. REGARDLESS OF THE APPROVAL ON ANY SUBSTITUTION, ALL BIDS SHALL BE BASED ON THE PRODUCTS EXACTLY AS SPECIFIED. PRICING FOR EACH APPROVED SUBSTITUTION SHALL BE INCLUDED IN THE BID SUBMITTAL AS A SEPARATE LINE ITEM.
2. In the event that written authorization is given for a substitution, after award of contract, the Contractor shall submit to the Engineer quotations from suppliers/distributors of both the specified and proposed equal material for price comparison, as well as a verification of delivery dates that conform to the project schedule.
3. In the event of cost reduction, the Owner will be credited with 100 percent of the reduction, arranged by Change Order.

4. The Contractor warrants that substitutions proposed for specified items will fully perform the functions required.

D. Alternates/Alternatives: For the purposes of specifying products, “alternatives/alternates” may be established to enable the Owner/Architect/Engineer to compare costs where alternative materials or methods might be used. An alternate price shall be submitted in addition to the base bid for consideration. If the alternate is deemed acceptable, written authorization will be issued.

E. No Known Equal: For the purposes of specifying products, “No Known Equal” shall mean that the Owner/Architect/Engineer is not aware of an equivalent product. The Contractor will need to submit a “Substitution” item, per the requirements listed above, if a different product is proposed to be utilized.

1.10 SHOP DRAWINGS/SUBMITTALS

A. Shop Drawings/Submittals, unless required otherwise by general project specifications or instructions to bidders, shall be submitted in electronic format (PDF) to include a Letter of Transmittal (PDF), which shall give a list of the drawings submitted with dates and/or system(s) components contained within the submittal. Drawings and material cut sheets shall be complete in every respect and edited/marked to indicate specific items being provided. Printed/Hard copies are not acceptable.

B. The Shop Drawings/Submittals shall be marked with the name of the project, numbered consecutively, and bear the approval of the Contractor as evidence that the Contractor has checked the Drawings. Any Drawings submitted without this approval will be returned to the Contractor for resubmission.

C. If the shop drawings show variations from the requirements of the Contract because of standard shop practice or other reasons, the Contractor shall make specific mention of such variations in the Contractor’s letter of transmittal. If the substitution is accepted, the Contractor shall be responsible for proper adjustment that may be caused by the substitution. Samples shall be submitted when requested.

D. Only products listed as “Equal” within the contract documents, along with formally approved “Substitutions” will be reviewed. Products not conforming to these items will not be reviewed and will be returned to the Contractor for re-submittal.

E. Review comments used in response to shop drawings/submittals are:

1. “No Exception Taken” - Product approved as submitted.
2. “Furnish as Corrected” - Re-submittal not required, although the Contractor shall provide the submitted product with corrections as noted.
3. “Revise and Resubmit” - Re-submittal required with corrections as noted.
4. “Rejected” - Re-submittal required based upon the originally specified product.

F. Shop drawings shall be submitted on the following but not limited to:

1. Lighting Fixtures, Lamps, and Ballasts.
2. Switchgear, Switchboards, Distribution Boards, Motor Control Centers, Panel boards, and Bus Ducts; complete with overcurrent device information.
3. Transformers.
4. Fire Alarm System/Central Monitoring System.
5. Wiring Devices.
6. Lighting Control System/Dimming System Products.

7. Pullboxes and Underground Vaults.
8. Terminal Cabinets
9. Lighting Inverters, UPSs, RDCs, PDUs, Generators, Transfer Switches, SPD Systems.
10. Cable Tray, Flexible Cable Tray and Cable Runway.
11. Power Poles and Floor Boxes.
12. Arc Flash, Short-Circuit and Coordination studies.
13. All other products called out on drawings that call for shop drawing submittal.

1.11 MAINTENANCE, SERVICING, INSTRUCTION MANUALS AND WIRING DIAGRAMS

A. Prior to final acceptance of the job, the Electrical Contractor shall furnish to the Owner at least four (4) copies of operating, maintenance, and servicing instructions, as well as four (4) complete wiring diagrams for the following, but not limited to, items or equipment:

1. Lighting Control System/Dimming Systems.
2. Fire Alarm System.
3. Transformers.
4. Switchgear, Switchboards, Distribution Boards, Motor Control Centers, Panel boards, and Bus Ducts; complete with overcurrent device information
5. Lighting Inverters, UPS's, PDUs, Generators, Transfer Switches, SPD Systems

B. All wiring diagrams shall specifically cover the system supplied. Typical drawings will not be accepted. Four (4) copies shall be presented to the Owner.

1.12 INTERRUPTION OF SERVICE/SERVICE SHUTDOWN

A. Any interruption of electrical services, electrical circuits, electrical feeders, signal systems, communication systems, fire alarm systems, etc. required to perform work, shall meet the specific prior-approval requirements of the Owner. Such work shall be scheduled with the Owner to be performed at the Owner's convenience.

B. Interruptions/outages of any of the Owner’s systems and services mentioned above shall be scheduled to occur during other than the Owner’s normal business hours. Any overtime costs shall be borne by the Contractor.

C. See drawings for any additional requirements regarding outages, interruption and any temporary services required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials and Equipment: All electrical materials and equipment, including custom-made equipment, shall be new and shall be listed by Underwriter's Laboratories (UL) and bear their label or be listed and certified by a Nationally Recognized Testing Lab (NRTL) that is also recognized by the local Authority-Having-Jurisdiction (AHJ)

B. Switchgear/Switchboards/Distribution Boards/Motor Control Centers:

1. See general single line notes on single line drawing for more information.

C. Panel boards – Branch Circuit:

1. See drawings for panel board schedules and specifications.

D. Transformers:

1. See drawings for transformer schedules and specifications.

E. Lighting Fixtures:

1. See drawings for lighting fixture and lamp schedules and additional specifications. Furnish, install and connect a lighting fixture at each outlet where a lighting fixture type symbol (designated on plans) is shown as being installed. Each fixture shall be complete with all required accessories including sockets, glassware, boxes, spacers, mounting devices, fire rating enclosure and lamps.
2. Ballasts: See lighting fixture schedule notes. All noisy ballasts shall be replaced at no cost to the Owner.
3. Lamps: See lamp/fixture schedule and lamp/lighting fixture schedule notes.

F. Wiring Devices:

1. Provide wiring devices indicated per plan. Devices shall be specification grade. Acceptable manufacturers are Leviton, Pass and Seymour and Hubbell. Provide all similar devices of same manufacturer, unless indicated otherwise. All device colors shall be from the full range of manufacturer standard color options as selected by the Architect. This selection will be made during the shop drawing review process

a. Wiring Devices (Decora)

1)	Convenience Receptacle	#16252- ???
2)	Dedicated Receptacle	#16352-???
3)	Convenience I.G. Receptacle	#16262-IG-???
4)	Dedicated I.G. Receptacle	#16362-IG-???
5)	Convenience G.F.C.I. Receptacle	#GFT1-???
6)	Dedicated G.F.C.I. Receptacle	#GFNT2-???
7)	Convenience Hospital Grade Receptacle	#16252-HG?-???
8)	Dedicated Hospital Grade Receptacle	#16352-HG?-???
9)	Convenience G.F.C.I. Hospital Grade	#GFNT1-HG?
10)	Dedicated G.F.C.I. Hospital Grade	#GFNT2-HG?
11)	Tamper Resistant Convenience Receptacle	#TDR15-???
12)	Tamper Resistant Dedicated Receptacle	#TDR20-???
13)	Tamper Resistant GFCI Receptacle	#GFTR2-???
14)	Tamper Resistant. Convenience. G.F.C.I. Hospital Grade Receptacle	#GFTR1-HG?
15)	Tamper Resistant. Dedicated. G.F.C.I. Hospital Grade Receptacle	#GFTR2-HG?
16)	Weather/Tamper Resistant GFCI Receptacle	#GFWT2-???
17)	Convenience Simplex Receptacle	#16251-???
18)	Dedicated Simplex Receptacle	#16351-???
19)	Recessed Clock Receptacle	#5361-CH-???(Non-Decora)
20)	Single Pole Switch	#5621-2-???
21)	Double Pole Switch	#5622-2-???
22)	Three Way Switch	#5623-2-???
23)	Four Way Switch	#5624-2-???
24)	Pilot Light Switch “On”	#5628-2-???
25)	Pilot Light Switch “Off”	#5631-2-???

26)	Projection Screen Switch	#5657-2-???
27)	Low Voltage Momentary Switch	#5657-2-???
28)	Keyed Switch	#1221-2L-???(Non-Decora)
29)	Door Jam Switch	#1865-???

b. Use of dedicated receptacles is required where plans depict a branch circuit supplying only a single simplex or duplex receptacle. Use of controlled receptacles is required where depicted on plans - see controlled receptacle specifications for additional information.

2. I.G. (isolated ground) receptacle bodies shall be of a basic color specified above with an orange triangle to symbolize isolated ground.
3. H.G. (hospital grade) receptacle bodies shall be of a basic color specified above with a green circle to symbolize hospital grade.
4. When shown circuited with an I.G. conductor, receptacles shall be of an I.G. type. As an example, a NEMA L6-30R denoted on the plans and shown circuited with an I.G. conductor shall be an I.G. version of that receptacle.
5. Wiring devices located in wood finished areas shall generally be black unless otherwise indicated by the Architect.
6. Wiring devices located in mirrors shall generally be white with stainless steel cover plates unless otherwise indicated by the Architect.
7. In addition to other device requirements listed elsewhere in this specification and NEC, or CEC where adopted, Articles 406.12 & 517.18, all 125V & 250V, 15A and 20A, non-locking receptacles shall be Tamper-Resistant when located in the following locations:

   a. In business offices, corridors, waiting rooms, and the like in clinics, medical and dental offices and outpatient facilities.

8. Wiring device cover plates located on recessed boxes shall be commercial grade nylon. Plate color shall match wiring device color UON on plans. Cover plates utilized on surface mounted boxes shall be metal. Plastic cover plates are unacceptable.
9. Except as otherwise noted, all wiring device plates on the project shall be labeled with panel and circuit number(s) utilizing a Brother P-Touch labeling system with 1/2" tape (yellow on black) or equal by Herman-Tellerman or Panduit. Locate label on the concealed side of the wiring device plate. Handwritten labels are unacceptable.
10. The Contractor shall provide duplex receptacle outlets in the appropriate configurations necessary to comply with applicable energy code requirements for controlled receptacles and as shown on plans. All wiring devices indicated to be controlled receptacles shall be NEMA-approved, electrical code-compliant with factory markings on the face of the receptacle(s) with the word "Controlled" or utilize further markings and symbols to indicate which receptacles on each outlet is/are controlled. Stickers, field-applied markings or other non-permanent markings are not acceptable. Where a GFCI receptacle outlet is required to be controlled, provide an adjacent controlled duplex receptacle outlet connected on the load side of the GFCI outlet. Generally, one receptacle in a duplex receptacle outlet is required to be controlled. It may be the lower receptacle or upper receptacle based on manufacturer offering. However, the controlled receptacle location within a controlled receptacle outlet shall remain consistent throughout the project. Where an existing duplex receptacle outlet is required to be controlled, provide a new wiring device with the appropriate control configuration necessary to comply with plans. All controlled receptacles shall be connected to a branch circuit controlled by an occupancy sensor-based or relay panel lighting control system. Acceptable manufacturers are Leviton, Pass and Seymour and Hubbell.
11. The following wiring device plates shall have custom engraving:

a. Key operated switches, switches with pilot lights, and switches for the control of motors, heaters and ventilators. Engraving shall be black and occur on the exposed side of the plate indicating the motor, heater, or ventilator controlled.

b. Receptacles on UPS power shall have custom engraved plates with the words "UPS" in black letters. In addition, where located in telecommunications closets, IDFs, server rooms, data centers, labs (wet, dry or electronic) indicate panel board and circuit number.

c. All stainless steel and nylon device plates shall be engraved using a rotary engraving process except for black lettering on stainless steel device plates which may be accomplished via laser etching process. All lettering shall be 3/16" high. Provide a dimensioned submittal drawing detailing a typical device faceplate with engraving.

G. Weatherproof Outlet Covers/Assemblies: All Receptacles identified as weatherproof on the drawings shall be weather-resistant, tamper-resistant, GFCI type and equipped as follows:

1. Type WP-A: Recessed wall box with a hinged, lockable, cast aluminum, self-closing, gasket-equipped door that is wet location-listed rain tight while "in use". Unit shall comply with NEC, or CEC where adopted, Article 406.9(A) and (B). UON on drawings, provide a minimum of 2 separate compartments suitable for installation of power receptacles, AV or communications outlets. Additionally, unless otherwise noted on drawings, provide the following:

   a. A 20A weather-resistant, tamper-resistant, GFCI duplex receptacle in the first compartment. Provide branch circuiting per plans.
   b. A blank metal plate suitable for field installation of power, AV or communications devices in the second compartment.
   c. Where indicated on plans as requiring data, AV, or other low voltage service outlet, provide minimum 3/4" C.O. with pull string routed from the second compartment to nearest low voltage pull box. Where shown mounted in a building wall, any blank/unused compartment shall be equipped min. 3/4" C.O. with pull string routed to the nearest accessible ceiling space.
   d. See wiring device section of this specification for additional wiring device plate cover labeling requirements.
   e. 1 key minimum per device (minimum of 2 per project) to the Owner's project manager upon completion of project.
   f. Custom color powder coat finish as selected by Architect - Include all costs in base bid for same.
   g. In locations with sufficient wall depth, provide 6" wide x 6" tall x 5-1/2" deep recessed wall box (C.W. Cole #TL310-WCS-K1-CUSTOM COLOR).
   h. In locations utilizing shallow stud walls construction or other walls of insufficient depth, provide 10-3/4" wide x 7-3/8" tall x 3-7/8" deep recessed wall box (C.W. Cole #TL310-WCS-SH-K1 -CUSTOM COLOR).
   i. See drawings for additional details.

2. Type/Subscript WP-B: Wet location-listed raintight while "in use" cast copper-free aluminum, extra-duty, lockable cover with baked aluminum lacquer finish and one gang, weather-resistant, tamper-resistant GFCI receptacle. Hubbell WP26E series. Polycarbonate covers are unacceptable. Unit shall comply with NEC, or CEC where adopted, Article 406.9(A) and (B). Contractor shall powder coat cover assembly to a custom color where receptacle locations are deemed by the Architect to be in aesthetically sensitive or public spaces. Custom color as selected by Architect.
3. Type WP-C: (C.W. Cole #TL310-WCS-PED-ADA-K1-CUSTOM COLOR or #TL310-WCS-PED-K1-CUSTOM COLOR) pedestal device box with a hinged, lockable, cast aluminum, self-closing, gasket-equipped door that is wet location-listed raintight while "in use". Unit

shall comply with NEC, or CEC where adopted, Article 406.9(A) and (B). UON on drawings, provide a minimum of 2 separate compartments suitable for installation power receptacles, AV or communications outlets. Additionally, unless otherwise noted on drawings, provide the following:

a. A 20A weather-resistant, tamper-resistant, GFCI duplex receptacle in the first compartment. Provide branch circuiting per plans.
b. A blank metal plate suitable for field installation of power, AV or communications devices in the second compartment.
c. Where indicated on plans as requiring data, AV, or other low voltage service outlet, provide minimum 3/4" C.O. with pull string routed from the second compartment to nearest low voltage pull box.
d. See wiring device section of this specification for additional wiring device plate cover labeling requirements.
e. 1 key minimum per device (minimum of 2 per project) to the Owner's project manager upon completion of project.
f. Include all costs in base bid for ADA version (22.5" tall) of pedestal box. Prior to ordering material, contractor shall coordinate with Architect and/or AHJ to determine which pedestal box locations do not require ADA compliance and may be changed to the standard (11.5" tall) version of the pedestal box.
g. Custom color powder coat finish as selected by Architect. Include all costs in base bid for same.
h. See drawings for additional details.

4. Type/Subscript WP-D: Damp location-listed (not-Raintite-in-use) cast copper-free, pad lockable, die-cast aluminum cover with baked aluminum lacquer finish and one gang GFCI receptacle. Hubbell/Rayco 502?/503? Series. Polycarbonate covers are unacceptable. Unit shall comply with NEC, or CEC where adopted, article 406.9(A) and (B). Custom color powder coat finish as selected by Architect. Include all costs in base bid for same.

H. Motor Controllers/Starters: See drawings for motorized equipment schedules and specifications.

I. Circuit Breakers:

1. Service entrance circuit breakers smaller than 400A (Amp) frame shall be thermal-magnetic trip with inverse time current characteristics unless otherwise indicated below. Service entrance main circuit breakers and main circuit breakers, 400A frame and larger, shall be 100% rated, solid-state type as outlined in this specification. All other service entrance circuit breakers, 400A frame and larger, shall be 100% rated, solid-state type as outlined in this specification.
2. All non-service entrance circuit breakers 225A and larger shall be thermal magnetic type and have continuously adjustable instantaneous pick-ups of approximately 5 to 10 times trip rating. Breakers shall have either tamper-resistant rating dials or easily changed trip rating plugs with trip ratings as indicated on the Drawings. Rating plugs shall be interlocked so they are not interchangeable between frames. Additionally, all non-service entrance circuit breakers, 600A frame and larger, located in 480V, 3-phase, 3-wire or 277/480V, 3-phase, 4-wire switchgear, distribution boards, panel boards or busway plugs shall be solid state, 100% rated. Breaker shall have built-in test points for testing long delay, short delay and instantaneous, and ground fault (where shown) functions of the breaker by means of a 120V operated test kit. Contractor shall utilize a test kit capable of testing all breakers 400A and above - at the Engineer’s request.
3. All non-service entrance circuit breakers less than 225A shall be molded plastic case, air circuit breakers conforming to UL 489. Provide breakers with thermal magnetic trip units, and a common trip bar for two- or three-pole breakers, connected internally to each pole so tripping of one pole will automatically trip all poles of each breaker. Provide breakers of trip-free and trip-indicating bolt-on type, with quick-make, quick-break contacts. Provide

single two- or three-pole breaker interchangeability. Provide padlocking device for circuit breakers as shown on the Drawings.

4. Where a Current Limiting Circuit Breaker (CLCB) is indicated on drawings or as required elsewhere in this specification, provide a UL listed current limiting thermal magnetic circuit breaker(s) UON. An independently operating limiter section within a molded case is not allowed. Coordinate CLCB ratings as required to protect electrical system components on the load side of the CLCB to include, but not limited to, protecting automatic transfer switches, panel boards and lighting control panels.
5. Where a solid-state circuit breaker is indicated on drawings or as required elsewhere in this specification, provide a solid-state circuit breaker with minimum five function complete with built-in current transformers. The five functions shall be independently adjustable and consist of Overload/Long Time Amp Rating, Long Time Delay, Short Time Delay, Short Circuit/Instantaneous Pickup, but may also include Shunt Trip and/or Ground Fault if so indicated on the Drawings. Rating plugs shall be interlocked so they are not interchangeable between frames. Breaker shall have built-in test points for testing long delay and instantaneous, and ground fault (where shown) functions of the breaker by means of a 120V operated test kit. Contractor shall utilize a test kit capable of testing all breakers 400A and above, at the Engineer's request.
6. Circuit breakers, 1200A Frame or larger, or circuit breakers with sensors or adjustable trip settings, 1200A or larger, shall be equipped with an Energy Reducing Maintenance Switch that complies with NEC, or CEC where adopted, 240.87 (B) (3) unless specified elsewhere with an alternate arc energy reduction method allowed by this same code section.
7. Ground Fault Interrupting Breakers: Provide with molded plastic case, air circuit breakers, similar to above with ground fault circuit interrupt capability, conforming to UL Class A, Group 1.
8. Arc Fault Interrupting Breakers: Provide with molded plastic case, air circuit breakers, similar to above with arc fault circuit interrupt capability, conforming to UL 1699. Provide on all dwelling-unit circuits supplying bedrooms, sleeping quarters etc. as required to comply with NEC, or CEC where adopted, Article 210.12.
9. Tandem or half-sized circuit breakers are not permitted.
10. Series-Rated Breakers: UL listed series-rated combinations of breakers can be used to obtain panelboard-interrupting ratings shown on Drawings. If series-rated breakers are used, switchboards, distribution boards, and panel boards shall be appropriately labeled to indicate the use of series-rated breakers. Shop drawing submittal shall include chart of UL listed devices, which coordinate to provide series rating.
11. Circuit breakers shall be standard interrupting construction. Panelboard shall accept standard circuit breakers up to 100A.
12. Circuit breaker handle accessories shall provide provisions for locking handle in the on or off position.
13. Shunt-trip equipped circuit breakers shall be provided on all elevator feeders.
14. Temperature compensating circuit breaker(s) shall be provided when located in outdoor enclosure(s) or when located in an enclosure subject to high ambient heat due to due nearby industrial processes, etc.
15. Provide 75 degree Celsius-rated conductor lugs/lug kits as required on all circuit breakers to accept conductor quantities and sizes shown on drawings.
16. All circuit breaker terminations shall be suitable for use with 75-degree Celsius ampacity conductors. Listed, dual-rated pin terminals, straight or offset, are acceptable for use to in accommodating oversized or parallel conductor installations.
17. Circuit breakers serving Fire Alarm or Central Monitoring panels and power supplies shall be red in color and lockable in the "ON" position.

J. Disconnect Switches:

1. Non-fusible or fusible, heavy-duty, externally-operated horsepower-rated, 600V A.C: Provide NEMA 3R, lockable enclosures for all switches located on rooftops, in wet or damp areas and in any area exposed to the elements.

2. Fusible switches shall be Class “R” when 600A or less or Class “L” when greater than 600A.
3. Amperage, Horsepower, Voltage and number of poles per drawings: All shall be clearly marked on the switch nameplate.
4. Provide the Owner’s project manager with one (1) spare set of fuses and two (2) sets of fuse clips/fuses for every set of fuses on the project.

K. Fuses:

1. Provide fuses at all locations shown on the Drawings and as required for supplemental protection:

   a. Fuses shall be manufactured by Bussman, Shawmut, or equal.
   b. All fuses shall be the product of a single manufacturer.

2. Main and Feeder Protection:

   a. Protective devices rated greater than 600A: Provide Bussman Hi-Cap fuses, Class L, current limiting, having an interrupting rating of 200,000A RMS.
   b. Protective devices rated 600A or less: Provide Bussman Class R fuses, Class RK series current limiting fuses, having an interrupting rating of 200,000A RMS.

3. Motor Protection:

   a. Where rating of protective device is greater than 600A, provide Bussman Hi-Cap fuses, Class L, current limiting, having an interrupting rating of 200,000A RMS.
   b. Where rating of protective device is 600A or less, provide Bussman Class RK series current limiting fuses, having an interrupting rating of 200,000A RMS.
   c. Where fuses feeding motors are indicated, but not sized, it shall be the responsibility of the Contractor to coordinate the fuse size with the motor to provide proper motor running protection.
   d. When rejection type fuses are specified (Class RK series) the fuse holder of all switches (specified in other Sections) shall be suitable for the fuses provided.

L. Cable Tray, Flexible Cable Tray and/or Cable Runway:

1. See drawings for Cable Tray, Flexible Cable Tray and/or Cable Runway specifications.

M. Uninterruptible Power Systems (UPS):

1. See drawings for UPS schedules and specifications.

N. Power Distribution Units (PDU):

1. See drawings for PDU schedules and specifications.

O. Lighting Control/Dimming Systems:

1. See drawings for Lighting Control and/or Dimming Systems schedules and specifications.
2. Wall box dimmers shall be rocker-type as manufactured by Lutron (no known equal except as noted below). Dimmers and dimmer faceplates shall match the color of adjacent switches and faceplates. Dimmers and dimmer faceplates in wood finished areas shall generally be black unless otherwise indicated by the Architect. The Contractor shall obtain written approval of the Architect regarding final dimmer and dimmer faceplate color

selection prior to ordering material. Multiple dimmers/switches shall be ganged together with a common cover plate. Provide dimmers as follows:

a. Incandescent: Lutron DIVA DV-10P or DV-103P (3-way) (1000-Watt max.).
b. Electronic Low Voltage: Lutron DIVA DVELV-300P or DVELV-303P- (3-way) (300 Watt).
c. Magnetic Low Voltage: Lutron DIVA DVLV-10P or DVLV103p (3-way) (800-Watt max.).
d. Fluorescent (3-Wire): Lutron DIVA DVF-103P (single/3way, 8A @ 120V) or DVF-103P-277 (single/3way, 6A @ 277V).
e. Fluorescent (0-10V): Lutron DIVA DVTV with PP-???H Power Pack.
f. Fluorescent (Lutron Tu-Wire): Lutron DIVA DVFTU-5A3P with Lutron H.P. module where required.
g. LED (0 - 10V): Lutron DIVA DVTV with PP-???H Power Pack.
h. Screw Base CFL/LED: Lutron DIVA DVCL-153P.
i. Fan Control: Lutron DIVA DVFSQ-F (1.5A @ 120V max, 3 speed, single pole, 3-way).

3. Contractor shall verify if dimmer(s) requires derating when ganged. Contractor shall provide, and provide connections to, additional Lutron Power Modules, Lutron Power Packs, and / or Lutron Interface Modules where required to accommodate loads higher than dimmers standard or derated load-carrying capacity. Note - contractor may to provide a Lutron recommended dimmer type (typically a #DVF-103P unit) to control the necessary power modules or interface devices.

P. Fire Alarm System/Central Monitoring System:

1. See drawings for Fire Alarm System or Central Monitoring System specifications.

Q. Surge Protective Device (SPD):

1. See drawings for SPD specifications.

R. Conduit:

1. Galvanized Rigid Conduit (GRC) shall be full weight threaded type steel. Steel conduit shall be protected by overall zinc coating to inside and outside surfaces, applied by the hot dip, metalizing, or sherardizing process.
2. Intermediate Metal Conduit (IMC), shall be hot-dipped galvanized in accordance with UL 1242, and meet Federal Specification WWC-581 (latest revision).
3. Electrical Metallic Tubing (EMT) shall be zinc-coated steel with baked enamel or plastic finish on inside surfaces. EMT shall be dipped in a chromic acid bath to chemically form a corrosion-resistant protective coating of zinc chromate over galvanized surface.
4. Flexible metal conduit shall be constructed of aluminum or hot-dipped galvanized steel strips wound spirally with interlocking edges to provide greatest flexibility with maximum strength. Interior surfaces shall be smooth and offer minimum drag to pulling in conductors. Use only as directed in writing by the Engineer with the exception of 400 Hz feeders and 400 Hz branch circuits which shall be run in flexible aluminum conduit.
5. Liquid-tight conduit (Seal-Tite) shall be galvanized steel flexible conduit as above except with moisture and oil-proof jacket, pre-cut lengths and factory-installed fittings. For outdoor installations and motor connections only unless otherwise noted on drawings.
6. Factory assembled, or off-site assembled wiring systems (such as Metal Clad (MC) Cable, Type AC Cable, Type NM Cable, Type BX Cable, etc.) shall not be used unless otherwise indicated in the Allowed Specification Deviations Section or Deductive/Additive Alternate Pricing Section generally located on the symbols list drawing.

7. When approved for use in the Allowed Specification Deviations Section, generally located on the symbols list drawing, MC cables shall be allowed for lighting branch circuits (homeruns shall be EMT), receptacle branch circuits (homeruns shall be EMT) and poke-thru fed systems furniture homeruns. MC shall not be used where exposed, except for a maximum 6' length for final connections to light fixtures, or terminate in electrical panelboards or distribution boards. Equipment ground conductor shall be green. Isolated ground conductor shall be green with yellow stripe. Provide 600V rated aluminum or lightweight steel interlocking armor Metal Clad (MC) cable with copper conductors, THHN (90-degree C) insulation, and integral equipment grounding conductor and isolated grounding conductor as required. Type AC cable listed for use in patient care areas for non-essential electrical system branch circuits per NEC or CEC where adopted, Article 517.13 shall be required in such areas in lieu of MC cable. Type AC and MC cable shall not be used for essential electrical system branch circuits. MC cable shall be manufactured to Underwriter Laboratory Standard 1569. See PART 3 - EXECUTION section of this specification for additional installation requirements.
8. Nonmetallic Flexible Tubing (ENT) shall not be used unless otherwise indicated in the Allowed Specification Deviations Section or Deductive/Additive Alternate Pricing Section generally located on the symbols list drawing. Use of ENT, if allowed, is strictly limited to use in CMU walls and parking structures decks or as directed in writing by the Engineer. See PART 3 - EXECUTION section in this specification for additional installation requirements.
9. Non-Metallic Conduit:

    a. Polyvinyl chloride (PVC) rigid conduit, Schedule 40, Type II for underground installation only with solvent welded joints, conforming to Underwriters Laboratories, Inc. (UL) requirements, listed for exposed and direct burial application.
    b. Conduit and fittings shall be produced by the same manufacturer.

10. Fire-rated MC Cable:

    a. 2-hour fire-rated, polymer insulated 600V MC cable listed and conforming to Underwriters Laboratories, Inc. (UL) 2196 and UL 1569 requirements for installation as an Electrical Circuit Protective System for use in complying with NEC, or CEC where adopted, Articles 695 and 700. Where adopted, cable sheath shall be suitable for use as a NEC or CEC equipment grounding conductor, and shall be listed for use in wet locations to 90 degrees C (Raychem or equal).
    b. Cable connectors shall be brass MC connectors.

S. Fittings:

1. Condulet type fittings shall be smooth inside and out, taper threaded with integral insulating bushing and of the shapes, sizes and types required to facilitate installation or removal of wires and cables from the conduit and tubing system. These fittings shall be of metal, smooth inside and out, thoroughly galvanized, and sherardized cadmium plated.
2. Metallic condulet covers shall have the same finish as the fitting and shall be provided for the opening of each fitting where conductors do not pass through the cover.
3. Connector, coupling, locknut, bushings and caps used with rigid conduit shall be steel, threaded and thoroughly galvanized. Bushings shall be insulated.
4. UON all EMT fittings, connectors and couplings installed in concealed locations, areas not considered to be wet or damp locations by the AHJ, or areas not subject to physical damage, shall be steel, zinc or cadmium plated, threadless, compression, steel locking ring type with insulated throat. Where suitable for use, steel set screw fittings are allowed for trades sizes of 2" and smaller. Insulated throat is not required for fittings, connectors and couplings 1" and smaller.
5. All interior and exterior EMT fittings, connectors and couplings, 2" and smaller, installed in exposed or concealed locations that are considered by the AHJ to be wet or damp

locations, shall be Raintite-listed, steel, zinc or cadmium plated, threadless, compression, steel locking ring type with insulated throat. If Raintite-listed, EMT fittings, connectors and couplings are unavailable for a given trade size or if conduit is installed in an area subject to damage – provide rigid metallic or intermediate metallic conduits, fittings, connectors and couplings as required.

6. Flexible steel conduit connectors shall be a malleable iron clamp or squeeze type or steel twist-in type with insulated throat. The finish shall be zinc or cadmium plating.
7. Conduit unions shall be "Erickson" couplings, or approved equal. The use of running threads will not be permitted.

T. 600 Volt Conductors - Wire and Cable:

1. All conductors shall be copper. Provide stranded conductor for #10 AWG and larger or when making flexible connections to vibrating machinery. Use compression "fork" type connectors or transition to solid conductors when connecting to switches, receptacles, etc.
2. Type THHN/THWN-2 thermoplastic, 600 volt, UL approved, dry and wet locations rated at 90 degrees Celsius, for conductors of all sizes from #12 AWG up to and including 1000 kcmil. RHH/RHW insulation is allowed only to provide an Electrical Circuit Protective System to comply with NEC, or CEC where adopted, Articles 695 and 700.
3. Wire and cable shall be new, manufactured not more than six (6) months prior to installation, shall have size, type of insulation, voltage rating and manufacturer's name permanently marked on outer covering at regular intervals.
4. Wire and cable shall be factory color-coded by integral pigmentation with a separate color for each phase and neutral. Each system shall be color-coded and it shall be maintained throughout.
5. Systems Conductor Color Coding:

   a. Power 208/120V, 3PH, 4W:

      1) Phase A = Black
      2) Phase B = Red
      3) Phase C = Blue
      4) Neutral = White or White with Phase Color Tracer
      5) Switch legs = Purple (Switch legs shall also be identified separately by numerical tags).
      6) Travelers = Purple with Black stripe or Pink.

   b. Power 480/277V, 3PH, 4W:

      1) Phase A = Brown
      2) Phase B = Orange
      3) Phase C = Yellow
      4) Neutral = Grey or Grey with Phase Color Tracer
      5) Switch legs = Purple (Switch legs shall also be identified separately by numerical tags).
      6) Travelers = Purple with black stripe or Pink..

   c. Ground Conductors: Green
   d. Isolated Ground Conductors: Green with continuous yellow stripe.
   e. Fire Alarm System: As recommended by the manufacturer.

6. All color-coding for #12 through #6 AWG conductor shall be as identified above. Conductors #4 AWG and larger shall be identified with utilizing phase tape at each termination.
7. No conductors carrying 120V or more shall be smaller than #12 AWG.
8. Aluminum conductors shall not be used.

9. Wire-pulling compounds used as lubricants in installing conductors in raceways shall only be "Polywater J". No oil, grease, graphite, or similar substances may be used. Pulling of #1/0 or larger conductors shall be done with an approved cable pull machine. Other methods; e.g. using vehicles and block and tackle to install conductors are not acceptable.

U. Junction and Pullboxes:

1. For interior dry locations, boxes shall be NEMA 1 galvanized one-piece drawn steel, knockout type, with removable, machine screw secured covers.
2. For outside, damp or surface locations, boxes shall be NEMA 3R heavy cast aluminum or cast iron with removable, gasketed, non-ferrous machine screw secured covers.
3. For in-grade applications, junction and pull boxes shall be pre-cast concrete or molded fiberglass manufactured by Christy, Brooks-Jensen, or Utility Vault Co. Fiberglass boxes shall:

    a. Be used only in landscape planter areas that are not subject to damage from lawnmowers, tractors and other machinery.
    b. Not be used in lawn or turf areas.
    c. Not exceed 11” W x 17” L in size unless required to be larger to meet code requirements.

4. All boxes shall be sized for the number and sizes of conductors and conduits entering the box and equipped with plaster rings where required.
5. All boxes located in traffic areas shall be traffic rated.

V. Outlet Boxes:

1. For fixtures, boxes shall be galvanized, one-piece drawn steel, knockout type equipped with 3/8" fixture studs and plaster rings where required.
2. For convenience outlets, wall switches, or other devices, outlet boxes shall be galvanized one-piece drawn steel, knockout type 4" x 4"x 2-1/8" minimum size with plaster rings as required.
3. For locations where standard boxes are not suitable due to number and size of conduit to be terminated, special boxes shall be designed to fit space or meet other requirements, and submitted for approval.
4. For exposure to weather, damp locations, or surface mounting, outlet boxes shall be heavy cast aluminum or cast iron with threaded hubs; covers shall be watertight with gaskets and non-ferrous screws.
5. Outlet boxes used for support of ceiling fans shall be galvanized, one-piece drawn steel, knockout type equipped with bracing bars and plaster rings where required and listed for ceiling fan support use. Such boxes shall be labeled and capable of supporting ceiling fan weights up to 70 pounds.
6. See drawings for floor box installation notes and specifications.

W. Plywood Backboards: Where indicated for telephone or communications system terminals or other equipment assemblies, provide backboards of size indicated. Use 3/4" thick x 8' all (length per plans), Douglas Fir, void-free, kiln-dried, fire-rated plywood finished on one side and prime coat painted on all surfaces with finish coat of enamel paint, color by Architect. Leave one (1) fire-rating stamp/sheet exposed for inspection.

X. Terminal Cabinets:

1. Terminal cabinets shall be fabricated of hot dipped galvanized code gauge sheet metal for flush or surface mounting, complete with barriered sections, a door for each vertically barriered section and sizes as indicated on plan. Doors shall be hinged and lockable.

Locks shall be keyed to match the branch circuit panelboards. Terminal cabinet trims shall match the branch circuit panels.

2. Provide each terminal cabinet with a full size mounting backplate.
3. Terminal cabinets shall be installed complete with full-length skirts of the same construction and finish as the terminal cabinet.
4. Where mounted outdoors, terminal cabinets shall be NEMA 3R, weatherproof complete with gaskets and required sealant to prevent moisture from entering the terminal cabinet.
5. All terminal cabinets and terminal cabinet barriered sections shall be labeled by the cabinet or cabinet section use (i.e. CATV, Security, etc.). Labels shall be Micarta type as specified elsewhere in these specifications. Unless otherwise noted, all termination blocks and cables shall be labeled per ANSI/EIA 606 standard.

Y. Painting: Terminal cabinets, panels, junction boxes, pull boxes, etc., and conduit installed in public view shall be painted with colors selected by the Architect to match the subject surfaces. Refer to painting section of the specifications for additional requirements.

Z. Seismic Design, Certification and Anchoring of Electrical Equipment:

1. Contractor shall include all costs in the base bid for labor, materials, all special inspections and structural engineering design necessary to meet the Seismic Design Requirements for Non-structural Components (Chapter 13, ACE SEI 7-05 Minimum Design loads for Buildings and Other Structures) as required by IBC, or CBC where adopted, Section 1708 and as related to the installation all electrical equipment furnished under this contract. See Specific Project Site Seismic Criteria on architectural and/or structural plans which include Building Occupancy Category, Seismic Design Category, Design Spectral Response Acceleration (S_{DS}), Height factor ratio (z/h) and Site Class. Non-structural Component Importance Factor (I_P) for a particular component shall be determined based on the following criteria:

   a. I_P = 1.0: Non-life safety, Non-structural Components in an Occupancy Category IV Facility not required for continued operations of the facility or in any other Occupancy Category Facility where component failure will not impair continued operation of the facility.
   b. I_P=1.5: Designated Seismic Systems are those non-structural components in any Occupancy Category IV facility (except as noted above) or that are a part of any code-defined Critical, Life Safety, Emergency and Legally Required Standby Electrical System. Additionally, those non-structural components containing hazardous materials shall be classified as Designated Seismic Systems. While Designated Seismic Systems are generally identified on the plans, they may include items such as generators, automatic transfer switches, UPS units and all associated electrical distribution equipment and components necessary for the designated seismic system to form a complete and operable system. The Contractor shall ultimately be responsible for identifying Designated Seismic Systems. For any electrical component either identified on the plans or determined by the contractor to be a Designated Seismic System, all line and load side electrical distribution systems supporting that Designated Seismic System (including, but not limited to, feeders, panel boards switchboards, transformers, all related component supports and attachments etc.) shall be considered a part of the designated seismic system for the purposes of code-compliance and seismic certification.
   c. z/h - Height factor ratio: See plans for respective equipment locations.

2. Provide a delegated-design submittal for each of the following seismic-restraint systems to be used as required:

   a. Restraint Channel Bracings consisting of MFMA-4, shop-or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced

component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

b. Restraint Cables consisting of ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service, with a minimum of two clamping bolts for cable engagement.

c. Seismic-Restraint Accessories consisting of hanger rod/hanger rod stiffener assemblies, multifunctional steel connectors for attaching hangers to rigid channel bracings and/or restraint cables, bushings for floor and wall-mounted equipment anchor bolts and resilient isolation washers and bushings.

d. Mechanical Anchor Bolts consisting of 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 E 488.

e. Adhesive Anchor Bolts consisting of drilled-in and capsule anchor system containing resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide specific LEED-compatible environmentally-friendly resins and adhesives on all LEED projects. 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 E 488.

3. Submittal shall include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the contractor's structural engineer responsible for their preparation. Calculations shall include, but not be limited to, static and dynamic loading caused by equipment weight, operation, and seismic and, if applicable, wind forces required to select seismic and, if applicable, wind restraints and for designing vibration isolation bases. Provide seismic and wind-restraint detailing to support system selection, arrangement of restraints, attachment locations, methods, and spacings with all components identified to include their strengths, directions and values of forces transmitted to the structure during seismic events and association with vibration isolation devices. Sizes of components shall be selected so strength will be adequate to carry present static and seismic loads to accommodate 25% spare future capacity within specified loading limits.
4. Any pre-approval and evaluation documentation shall have a California Office of Statewide Health Planning and Development (OSHPD) Special Seismic Certification Preapproval (OSP) demonstrating horizontal and vertical load testing and analysis showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
5. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified elsewhere in the project specifications.
6. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment. Flexible connection limitations of the NEC, or CEC where adopted, shall apply.
7. Install seismic-restraint devices using methods approved by OSHPD or an agency acceptable to authorities having jurisdiction providing required submittals for component.
8. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by OSHPD or an agency acceptable to authorities having jurisdiction.

9. The contractor shall engage a qualified testing agency to perform tests and inspections as listed in other Project Specifications, but as a minimum shall include at least four of each type and size of installed anchors and fasteners selected by Architect. Schedule tests 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. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members as required. Test to 90 percent of rated proof load of device. Prepare and submit test and inspections reports.

AA. Trenching and Backfilling: Contractor shall be responsible for trenching and backfilling. Refer to Trenching and Backfilling section of the specifications for complete requirements.

PART 3 - EXECUTION

3.1 PREPARATION AND INSTALLATION

A. Installation of Conduit and Outlet Boxes:

1. All conduit installed in the dry walls or ceilings of a building shall be steel tube (EMT), aluminum tube (EMT), or Intermediate Metal Conduit (IMC). Flexible conduit shall not be used in lieu of EMT, IMC or rigid conduit except as noted herein.
2. Galvanized rigid conduit (GRC) or intermediate metal conduit (IMC) shall be used as follows:

    a. When noted on the drawings.
    b. When considered exposed to damage by the local AHJ.
    c. When installed in wet or damp locations and of a trade size where listed-Raintite fittings, connectors, couplings etc. are unavailable.
    d. When required by NEC or CEC Article 517.13.
    e. When installed in concrete and masonry. The use of ENT in CMU walls and parking structures may be allowed only as directed in writing by the Engineer. Request for ENT substitution must be made prior to bid and in accordance with pre-bid substitution requests requirements of these specifications.

3. Intermediate metal conduit (IMC), is approved for use in all locations as approved for GRC or steel-tube EMT and in accordance with NEC, or CEC where adopted, Article 342.
4. Flexible steel conduit shall only be permitted to be used at light fixture outlets and connections to vibrating electrical equipment. Except when concealed in walls or other structural elements, all flexible steel conduit runs shall be less than 6'-0". All outdoor installation shall be made using liquid-tight flex with approved fittings. Include a separate insulated green ground conductor sized per NEC in each conduit. Other uses of flexible conduit shall be allowed only as approved in writing by the Engineer.
5. Flexible liquidtight conduit shall be installed in lieu of the flexible steel; where required by the NEC, or CEC where adopted, in damp and wet location, where exposed to weather, in refrigerated area (65°F or less), and/or between seismic joints. All rotating electrical equipment shall be supplied with flexible, liquid-tight conduit with appropriate slack and shall not exceed thirty-six (36) inches. Include a separate insulated green ground conductor sized per NEC in each conduit. Other uses of liquidtight flexible conduit shall be allowed as approved in writing by the Engineer on a case by case basis.
6. Rigid metallic conduit installed underground or embedded in concrete shall be 1” trade size minimum and shall be wrapped with 20 mil. Polyvinylchloride plastic tape, PVC conduit installed underground or embedded in concrete shall be 3/4" minimum trade size.

7. Where required for providing an electrical circuit protective system to comply with NEC, or CEC where adopted, Articles 695 and 700 utilize UL Listed 2-hour fire-rated, MC cable or UL Listed 2-hour fire-rated RHH/RHW conductors in conduit.
8. Conduit shall be run so as not to interfere with other piping fixtures or equipment.
9. The ends of all conduit shall be cut square, carefully reamed out to full size and shall be shouldered in fitting.
10. No running threads will be permitted in locations exposed to the weather, in concrete or underground. Special union fittings shall be used in these locations.
11. Where conduit is underground, under slabs or grade, exposed to the weather, or in wet locations, make joints liquid tight and gas tight.
12. All metal conduit in masonry and concrete and where concealed under floor slabs shall have joints painted with thread compound prior to makeup.
13. PVC conduit shall not be run in walls except where approved by the Engineer prior to bid in limited instances that may include concrete or CMU walls used in site retaining, parking structures, or exterior equipment yard or enclosure walls, etc.
14. Where conductors enter a raceway or a raceway in a cabinet, pull box, junction box, or auxiliary gutter, the conductors shall be protected by a plastic bushing type fitting providing a smoothly rounded insulating surface.
15. Where conduit extends through roof to equipment on roof area, the Contractor shall provide flashing material compatible with the roofing system as required by the roofing specifications or as required by the Owner's roof warranty. This flashing shall be delivered to the roofing Contractor for installation. The actual location of all such roof penetrations and outlets shall be verified by the Architect/Owner. Contractor to verify type of flashing prior to bid and include all costs.
16. All conduit shall be supported at intervals not less than 6'-0" and within 12" from any outlet and at each side of bends and elbows. Conduit supports shall be galvanized, heavy stamped, two-hole conduit clamp properly secured.
17. Where conduit racks are used the rack shall consist of two-piece conduit clamps attached to galvanized steel slotted channels, properly secured via threaded rods attached directly to the building structure.
18. Nail-in conduit supports, one-piece set screw type conduit clamps or perforated iron for supporting conduit shall not be used.
19. Seismic Conduit Support:

    a. All conduit shall be supported in such a manner that it is securely attached to the structure of the building. Attachment is to be capable of supporting the tributary weight of conduit and contents in any direction. Maximum spacing of support and braces are to be as follows:

	CONDUIT SIZE	MAXIMUM SPACING
b.		
c.	1/2" to 3"	6'-0"
d.	3-1/2" to 4"	8'-0"

20. All conduit runs shall be installed parallel or perpendicular to walls, structural members, or intersection of vertical planes and ceilings. Field made bends and offset shall be avoided where possible. Crushed or deformed raceway shall not be installed.
21. Open knockouts in outlet boxes only where required for inserting conduit.
22. Locate wall outlet of the same type at same level in all rooms, except where otherwise noted.
23. Outlet boxes on metal studs shall be attached to metal hangers, tack welded or screwed to studs; on wood studs attachment shall be with wood screws, nails are not acceptable.
24. Recessed boxes shall not be mounted back-to-back in any wall; minimum offset shall be 24 inches.
25. Junction Boxes that do not contain any device(s) shall be located in storage rooms, electrical closets, or above accessible ceilings, not in hard lid ceilings or other forms of inaccessible ceilings. Place boxes which must be exposed to public view in a location

approved by the Owner's Project Manager. Provide covers or plates to match adjacent surfaces as approved by the Owner's Project manager.

26. Surface mounted pull boxes, terminal cabinets, junction boxes, panel boards etc., shall be attached to walls using appropriate screws, fasteners, backing plates, stud blocking etc., as detailed on architectural and/or structural drawings. If architectural and/or structural drawings are not provided on the project, Contractor shall provide all necessary mounting hardware and backing support to comply with local building code requirements and any additional requirements imposed by the local Authority-Having-Jurisdiction.
27. Sleeves shall be installed where conduit passes through masonry or concrete walls and shall be 24-gauge galvanized steel no more than 1/2" greater in diameter than the outside diameter of the conduit. When located in non-rated structures, caulk conduit sleeve with stone wool and waterproof below grade. When located in fire rated structures, provide UL listed fire stopping system. See fire stopping section of this specification for additional requirements.
28. All boxes shall be covered with outlet box protector, Appleton SB-CK, or similar device/method to keep dirt/debris from entering box, conduit or panels. If dirt/debris does get in, it shall be removed prior to pulling wires.
29. All boxes installed outdoors shall be suitable for outdoor installations, gasketed, screw cover, and painted as directed by the Architect with weatherproof paint to match building.
30. All conduit entries to outdoor mounted panels, cabinets, boxes, etc., shall be made using Myers "SCRU-TITE" hubs Series ST.
31. Provide nylon or a 1/8-inch O.D. polyethylene rope, rated at 250 pounds tensile strength, in all conduits more than 5 feet in length left empty for future use. Not less than 5 feet of rope shall be left at each end of the conduit. Tag all lines with a plastic tag at each end indicating the termination/stub location of the opposite end of the conduit.
32. All multiple conduit runs within suspended ceilings shall be suspended from building structure by means of unistrut hangers/racks, Conduit shall not be allowed to lay on ceiling or be supported from ceiling suspension wires or other suspension system. Support conduit to structure above suspended ceilings 8" minimum above ceiling to allow removal of ceiling tile. Maintain two-inch clearance above recessed light fixtures
33. All exposed conduits and support hardware shall be painted to match the finish of the wall or ceiling to which it is supported.
34. Where conduits or wireways cross seismic joints, provide approved flexible conduit connection or approved expansion/deflection fitting to allow for displacement of conduit in all three axes. Connection shall allow for movement in accordance with design of seismic joint. Non-flexible raceways crossing expansion joints or other areas of possible structural movement shall make provision for 3-way movement at such points by means of expansion/deflection fittings. Fittings shall be installed in the center of their axes of movement and shall not be deflected to make part of a conduit bend, or compressed or extended to compensate for incorrect conduit expansion/deflection fittings(s) complete with ground jumpers. Where necessary, provide approved expansion joints to allow for thermal expansion and contraction of conduit(s). Install expansion joints complete with ground jumpers.
35. Seal all conduits where termination is subject to moisture or where conduit penetrates exterior wall, floor or roof, in refrigerated areas, classified (hazardous areas) and as indicated on the drawings.
36. Except as otherwise indicated on the Drawings or elsewhere in these specifications, bends in feeder and branch circuit conduit 2 inches or larger shall have a radius or curvature of the inner edge, equal to not less than ten (10) times the internal diameter of the conduit. Except where sweeping vertically into a building, and where sweep radius equals ten (10) times conduit diameter, underground communications and building interconnect conduits 3 inches or larger shall have a minimum 12'-6" radius or curvature of the inner edge. For the serving utilities, radius bends shall be made per their respective specifications.
37. Tag all empty conduits at each accessible end with a permanent tag identifying the purpose of the conduit, footage end-to-end, and the location of the other end. In wet, corrosive outdoor or underground locations, use brass, bronze, or copper 16-gauge tags secured to

conduit ends with #16 or larger galvanized wire. Inscribe on the tags, with steel punch dies, clear and complete identifying information.

38. The following additional requirements shall apply to underground conduits:

    a. Underground conduit shall be Schedule 40 PVC (polyvinyl chloride) unless otherwise indicated elsewhere in these specifications or as required per NEC, or CEC where adopted Article 517.13.
    b. For all communications conduits 2" and larger and feeders 100A or greater, provide with a minimum 3" inch, (2,000 LB) concrete envelope, 2-inch minimum separation between conduits, installed at depth of not less than 24" below grade. (Provide concrete encasement and/or greater minimum conduit depth as required by the Utility Companies.) Conduit separation within a duct bank shall be maintained using plastic spacers located at 5'-0" intervals. Where power and communication conduits are run in a common trench, a 12-inch minimum separation shall be maintained between power and communication conduits or as required by Utility Companies. Where concrete encasement is not required by serving utilities for a utility-only duct bank, provide free draining sand bedding suitable to achieve 95% relative compaction based on ASTM D1557 using 6” lifts or directed by Utility Company Standards.
    c. In all cases, where any conduit(s) pass under a building slab or footing, the electrical Contractor will provide a Bentonite clay or concrete barrier that conforms to the height and width of the trench excavation extending a minimum of 24” on either side of the foundation. In all cases, where conduit(s) pass through a sleeve in a footing or other foundation element, the electrical Contractor will provide a Bentonite clay or concrete barrier between the sleeve and the conduit(s) surrounding the conduit(s) for the entire depth of the sleeve. The barrier is required to prevent passage of moisture under or through the slab or footing via the trench or sleeve.
    d. Where underground conduit passes under a building slab, concrete encasement may not be required, except as required above, contact the Engineer for written direction prior to omitting any encasement.
    e. Underground conduits, which terminate inside building(s) below grade, such as in a basement level, or which slope so that water might flow into interior building spaces, shall be sealed at the point of penetration with a modular conduit seal (Link-Seal or equal by Rox Systems). Conduit/conduit sealing system penetrations of waterproofing membranes/systems on existing structures shall be completely restored as required to maintain membrane/system manufacturer and installer warranty for the installation. All conduits shall be provided with a 4% slope away from buildings. All conduits shall be installed such that the water cannot accumulate in the conduit and such that water drains into the nearest manhole, pull box or vault – not into the facility. In instances where grade changes or elevation differences prevent sloping of conduit away from a building into the nearest manhole, pull box or vault or where accumulation of water in a manhole, pull box or vault may result in water traveling into the facility, conduits shall be sealed internally at each end of each conduit using conduit sealing bushing, sized as required for the conductors contained within the conduit (O-Z Gedney #CSBG 100psig withstand or equal). In all cases, install plugs or caps in spare (empty) conduits at both ends of each conduit (Jackmoon or equal) preventing both water and gas from entering the facility via the conduits.
    f. Include a separate insulated green ground conductor sized per NEC, or CEC where adopted, in each underground electrical feeder/branch circuit.
    g. All underground conduits with circuits rated at 40As or greater and all underground communications conduits shall be provided with a metallic marker tape located 12 inches below the finished grade.
    h. Where underground conduits sweep into/through slabs, utilize PVC 90 degree sweeps that transition, via female PVC adapter to GRC coupling mounted flush in slab. GRC couplings shall be 1/2 lap taped with 20-mil tape. If the distance of the

conduit run between a sweep and the next connecting sweep, pullbox, vault or manhole exceeds 150 ft then the sweep shall be concrete encased. Exceptions:

1) Communications conduits shown terminating at a finished floor shall have an additional 4" high GRC nipple equipped with a bushing, removable conduit plug, labeling tag and pull rope. Tie off pull rope to conduit plug.
2) Utility conduit sweeps shall be installed per the requirements of the respective utility company.

i. All PVC conduit shall be glued for a water and gas tight installation. The Contractor shall use appropriate solvent on all joints prior to gluing conduit and fittings together.
j. All underground conduit work shall conform to the Federal, State and Local Safety Orders or Rules regarding excavations, trenches and related earthwork. For projects in California, refer to the California Code of Regulations, Title 8, Construction Code Sections 1540 and 1541 for additional requirements.

39. Installation of Metal Clad (MC) Cable (when use is permitted in the Allowed Specification Deviations Section or Deductive/Additive Alternate Pricing Section, generally located on the symbols list drawing).

a. Provide J-box above accessible ceiling prior to running MC cable within partitions or walls. J-box shall be permanently labeled with panel identification and circuit numbers contained within.
b. Overhead MC cable runs shall generally follow building lines to provide a neat and workmanlike installation.
c. Provide code-sized J-boxes to accommodate MC cable splicing in general. For systems furniture poke-through feeds utilizing MC cable, transition from MC cables to conduit and wire near the panelboard in the TI accessible ceiling space on the floor below the panel board via code-sized gutter(s). Utilize UL listed, insulated barrier strips with recessed screw heads (Ideal #89-6?? Series or equal) fastened within the gutter(s), terminate MC conductors on one side of the strips(s) and individual conductors in conduit from the panelboard(s) on the other side of the strip(s). Label each terminal strip(s) with panel designation. Label each phase conductor with circuit number using wire markers (Ideal or equal). Wire nuts are not an acceptable alternative to the terminal strips in these underfloor transition locations. Provide (1) spare 3/4" conduit from each gutter to its respective panelboard.
d. MC cable shall not run directly into panelboards, distribution boards or electrical rooms.
e. MC cabling shall be provided with its own code-approved ceiling support wires, cable hangers, individual spring steel support clips, steel trapeze hangers, threaded roads or dedicated #10 AWG drop wire. Cable supports shall be fastened to concrete slabs, beams, joists or other structural members of the building. In no case shall MC cable rest on ceilings, suspended ceilings or structures. Do not support MC cable using ceiling support wires. The use of nylon cable ties to support MC cable is not allowed.
f. Use lock or spring nut MC cable fittings.
g. Cable runs shall be continuous from wiring device to wiring device – no intermediate splicing J-boxes allowed.
h. When terminating or splicing at a junction, outlet, or switch box, cut the cable with an armored cable rotary cutter such that 6-inches of free conductors remain for connections or splices. Use screw-in or spring lock connector and ensure a proper bonding by firmly tightening the connector to both the box and cable. Insert an anti-short bushing at cable ends to protect conductors from abrasion and use insulated connectors.

i. MC cable bend radius shall not e less than seven (7) times the external diameter of the cable.
j. MC cables passing through fire-rated walls or floors shall be firestopped as required with a UL listed system. See firestopping requirements outlined elsewhere in this specification for additional requirements.
k. Installation shall not exceed code requirements for total current carrying conductors in multiple MC Cable runs bundled together into a single MC cable hanger or strap, unless support device is specifically listed for such purpose. Neutrals shall be counted as current carrying conductors.
l. Maintain MC Cable clearance of at least 6 inches from hot water and any other high temperature pipes. Maintain at least 12-inches clearance between MC cable(s) and telecommunication conduits and cables. MC cable shall cross telecommunication cables and conduits at right angles.
m. MC cabling shall not be run through exposed ceilings, where open grid conditions exist, exposed on walls, or exposed to view. See Power Plan and Lighting Plan General Notes for additional requirements.

40. Installation of Electrical Nonmetallic Tubing (ENT) Cable (when use is permitted in the Allowed Specification Deviations Section or Deductive/Additive Alternate Pricing Section generally located on the symbols list drawing).

a. When approved for use in the Allowed Specification Deviations Section or Deductive/Additive Alternate Pricing Section, generally located on the symbols list drawing, 1/2" and 3/4" trade size ENT shall be allowed for concealed lighting branch circuits, receptacle branch circuits and miscellaneous signal system circuits within concrete floors, walls and columns within parking structures.
b. ENT conduit shall meet the requirements of Underwriters Laboratories Standards 1479 and 1655, NEMA TC-13, and be UL-listed.
c. All ENT conduit, ENT fittings, ENT boxes and ENT accessories shall be UL listed and manufactured by the same manufacturer so as to form a complete ENT system. ENT systems shall only be used if they are listed for use in fire resistance rated concrete floors and ceilings with resistance ratings as indicated elsewhere in the project plans. ENT system shall comply with NEC, or CEC where adopted, Article 362.
d. All ENT fittings and ENT boxes shall be concrete-tight listed without the use of tape. Additionally, ENT fittings shall be constructed of high impact PVC and able to resist ENT conduit pull out forces of a minimum of 175 lbs. ENT fittings with fewer than 6 locking tabs for ENT connection shall utilize manufacturer approved glue as additional protection from fitting/conduit separation. ENT conduit to rigid conduit transition fittings shall be equipped with set screw fittings on the rigid conduit side of the fitting. ENT to metal box fittings shall be equipped with a threaded end and lock washer.
e. Where tubing enters a box, fitting, or other enclosure provide a bushing or adapter to protect conductors from abrasion unless the box, fitting, or enclosure design provides equivalent protection.
f. ENT junction boxes shall have brass screw inserts and shall be rated to support lighting fixtures weighing less than 50 lbs.
g. Concrete tight metal boxes shall be used to support pendant hung fixtures or fixtures over 50 lbs.
h. ENT shall be provided in continuous lengths between junction boxes without use of in-line splices or connectors and shall be clearly marked/labeled at least every 10 feet.
i. All ENT conduit containing electrical branch circuits shall contain a code-sized equipment ground conductor.

j. ENT shall transition to EMT, IMC, RMC, or rigid PVC, as appropriate or as called out elsewhere in this specification, for all exposed conduits within/on/under a parking structure.
k. ENT shall transition to appropriately sized PVC expansion joint(s) at all structure expansion or seismic joints.
l. ENT shall be securely fastened and supported every 2 – 3 ft. and within 1 ft. of every junction box and fitting to prevent movement and sag.
m. ENT shall be routed straight without sags, or excessive bending. Where bends are required, comply with Table 362.24 of the NEC for minimum radius of bends. Number of bends shall not exceed quantity allowed by code where used for power and lighting branch circuit and/or feeder conductors. Where utilized for communications system conductors (phones, data cabling, etc.) number of bends shall not exceed the equivalent of (2) 90-degree bends with conduit length no more than 100 feet without installation of a TIA 569-compliant pull box.
n. Separation of ENT from fittings, excessive sags, or deflections in ENT runs that prevent pulling of wire and other ENT system product or system installation failures/errors shall be corrected by saw cutting and patching as necessary at no additional cost to the Owner. Use of surface mounted conduits and junction boxes as a repair method is unacceptable.
o. Empty ENT runs shall be provided with a nylon pull string.
p. Coordinate installation of raceway with structural steel and other structural members. Do not cut, notch or otherwise alter structural members without obtaining approval in writing from the Structural Engineer of record.
q. No more than (2) 3/4" ENT conduits may cross each other within a horizontal concrete slab without obtaining approval in writing from the Structural Engineer of record.

B. Installation of 600-Volt Conductors:

1. All electrical wire, including signal circuits, shall be installed in conduit.
2. All circuits and feeder wires for all systems shall be continuous from over current protective device or switch to terminal or farthest outlet. No joints shall be made except in pull, junction or outlet boxes, or in panel or switchboard gutters.

a. Utilize preinsulated "winged" spring type connectors, 3M Company "Performance Plus" #O/B or #R/Y or equal as required for splices and taps in conductors #6 AWG and smaller. When a spring connector is used in an underground environment or when subject to moisture, utilize a 3M Company Scotchcast 3507G epoxy resin connector sealing pack to seal the spring connector. THE USE OF PUSH-WIRE CONNECTORS (e.g. "WAGO" OR EQUIVALENT) IS STRICTLY PROHIBITED.
b. Wires #4 AWG and larger AWG shall be joined together as follows:

1) When located in an underground environment or when subject to moisture, the splice shall be made with compression connector and sealed by a 3M, or equal, PST cold shrink connector insulator.
2) When located in an interior environment, the splice shall be made with an Ilsco or equal dual rated, insulated splice-reducer connector or multi-tap connector-listed for use with 75/90-degree Celsius rated conductors.

c. Connections to busbar shall be made with dual-rated copper/aluminum one-piece compression lugs. Paralleled conductor connections shall be by mechanical lugs.

3. Thoroughly clean all conduit and wire-ways and see that all parts are perfectly dry before pulling any wires.
4. Install UL approved fixture wire from all lighting fixture lamp sockets into fixture outlet or junction box.

5. For 20A branch circuit wiring, increase #12 conductors to #10 for 120-volt circuits longer than 100 feet and for 277V circuits longer than 150 feet.
6. Conductor Support: Provide conductor supports as required by codes and recommended by cable manufacturer. Where required, provide cable supports in vertical conduits and provide lower end of conduit with a ventilator.

C. Grounding/Bonding:

1. Provide grounding and bonding for entire electric installation as shown on plans, as listed herein, and as required by applicable codes. Included, but not limited to, are items that require grounding/bonding:

   a. Conduit, Raceways and Cable Trays.
   b. Neutral or identified conductors of interior wiring system.
   c. Panel boards, Distribution Boards, Switchgear and Switchboards.
   d. Non-current carrying metal parts of fixed equipment.
   e. Telephone distribution equipment.
   f. Transformers, Inverters, UPS, PDU, RDC, Transfer Switch and Generator Systems.
   g. Raised Flooring.
   h. Exposed metal in maintenance holes, hand holes.
   i. Lightning Protection Systems and Antennas.
   j. Metal piping installed in or attached to a building/structure.
   k. Metallically isolated structural steel.
   l. Metallically isolated underground metal water piping.
   m. Elevator hydraulic piston/lift case.

2. Use of Ground Rods: Furnish and install required number of 3/4" x 10' copper clad ground rods to meet specified resistance, all required grounding wires, conduit and clamps. The size of the grounding conductors shall be not less than that set forth in the latest edition of the California Code of Regulations, Title 24, State of California and NEC (CEC, where adopted), unless otherwise indicated. Rods shall be installed such that at least 10 feet of length is in contact with the soil. Where rock bottom is encountered, the electrode shall be driven at an oblique angle not to exceed 45 degrees from vertical or shall be buried in a trench that is at least 30 inches deep. The upper end of the electrode shall be flush with or below ground level unless the above ground end and the grounding electrode conductor attachments are protected against physical damage. Unless otherwise noted, connection to the grounding electrode conductor may be by compression type or exothermic process connector. Mechanical connectors shall not be used.
3. Grounding System Connection:

   a. Compression connectors shall be unplated copper, manufactured by Burndy, or approved equal, designed specifically for the intended connection.
   b. Exothermic weld-type connectors shall be ‘Cadweld’ manufactured by Erico Products, or approved equal, designed specifically for the intended connection.
   c. Mechanical connectors shall not be used.

4. Isolated Ground Receptacles shall have an insulated ground wire connected between the receptacle and the panelboard isolated ground bus. Unless otherwise noted, this ground wire shall not be grounded at any other point, and shall be distinguished from other ground wires by a continuous yellow stripe.
5. Provide separate green equipment ground conductor in all electrical raceways to effectively ground all fixtures, panels, controls, motors, disconnect switches, exterior lighting standards, and noncurrent carrying metallic enclosures. Use bonding jumpers, grounding bushings, lugs, busses, etc., for this purpose. Connect the equipment ground to the building system ground. Use the same size equipment ground conductors as phase

conductors, up through #10 AWG. Use NEC (or CEC where adopted) Table 250.122 for conductor size with phase conductors #8 and larger, if not shown on the Drawings.

6. Clean the contact surfaces of all ground connections prior to making connections.
7. Ductwork: Provide a flexible ground strap, No. 6 AWG equivalent, at each flexible duct connection at each air handler, exhaust fan, and supply fan, and install to preclude vibration.
8. Motors: Connect the ground conductor to the conduit with an approved grounding bushing, and to the metal frame with a bolted solderless lug. Bolts, screws and washers shall be bronze or cadmium plated steel.
9. Building grounding system resistance to ground shall not exceed 25 ohms unless otherwise noted and should be confirmed by testing.

D. Line Voltage and Low Voltage Power Supplies to all Mechanical Equipment Including Plumbing, Heating and Air Conditioning Units:

1. An electric power supply, including conduit, any necessary junction and/or outlet boxes and conductors and connection shall be furnished and installed by the Contractor for each item or mechanical equipment.
2. Power supplies to individual items of equipment shall be terminated in a suitable outlet or junction box adjacent to the respective item of equipment, or a junction box provided by the manufacturer or the equipment and directed by the Mechanical Contractor. Allow sufficient lengths of conductor at each location to permit connection to the individual equipment without breaking the wire run.
3. The location of all conduit terminations to the equipment is approximate. The exact location of these conduit terminations shall be located and installed as directed by the Mechanical and Plumbing Contractor.
4. Provide power supplies to all plumbing and mechanical equipment, including but not limited to, equipment furnished and installed by Owner or Contractor such as heating and air conditioning equipment, pumps, boilers, auto valves, water coolers, trap primers etc. The installation shall produce a complete and operable system.
5. Unless otherwise noted, the Contractor shall furnish and install all conduit, boxes, wires, etc., for line voltage wiring and low voltage wiring.
6. It is the Contractor's responsibility to verify with the drawings of other trades regarding the extent of his responsibility for mechanical equipment. The bid must include a sum sufficient to cover the cost of the installation.
7. The location of all power supply connection and/or terminations to the mechanical equipment is approximate. The exact locations of these terminations shall be verified with other trades during construction.

E. Prefabricated Equipment: Installation of all prefabricated items and equipment shall conform to the requirements of the manufacturer's specifications and installation instruction pamphlets. Where code requirements affect installation of materials and equipment, the more stringent requirements, code or manufacturer's instructions and/or specifications, shall govern the work.

F. Firestopping:

1. The Contractor shall be responsible for furnishing all material, labor, equipment, and services in conjunction with the selection and installation of a complete, fully functioning, code compliant, UL-listed, fire stop assembly/system(s) as required by project conditions.
2. Each fire stop assembly/system shall have an "F" and/or "T" rating as required by each condition requiring fire stopping. Each fire stop assembly/system shall have a current UL listing, as indicated in the latest edition of the UL Fire Resistance Directory. Contractor shall verify acceptability of all fire stopping methods and system selections with the authority having jurisdiction prior to installation. The Contractor shall install each fire stop assembly/system in accordance with the manufacturer's printed instructions.

3. Each fire stop assembly/system shall be labeled with fire stop manufacturer-furnished label on each side of the fire stopping systems depicting UL # etc.

G. Housekeeping Pads

1. Provide a minimum 3" high housekeeping pad above finished floor/finished grade for all floor-mounted switchgear, switchboards, distribution boards, transformers, motor control centers, etc., flush with the face of the equipment. Located in mechanical central plant(s), other mechanical spaces, and located outdoors, pads shall be flush with the face of the equipment. Confirm pad dimensions with local inspector prior to forming pad to ensure any local code interpretations/conditions are met regarding housekeeping pads.
2. Unless otherwise noted above, provide a minimum 1-1/2" high housekeeping pad above finished floor/finished grade for all interior floor-mounted switchgear, switchboards, distribution boards, transformers, motor control centers, transfer switches etc., flush with the face of the equipment. All housekeeping pad heights are as measured from finished floor or grade. Confirm pad dimensions with local inspector prior to forming pad to ensure any local code interpretations/conditions are met regarding housekeeping pads.
3. Provide a 1-1/2" high housekeeping pad above finished floor/finished for service equipment. Prior to pad rough-in, Contractor shall verify serving utility company's maximum meter height requirements and, if necessary, adjust height of housekeeping pad to comply with those requirements. In indoor applications, the pad shall be flush with the face of the switchgear. In outdoor applications, the housekeeping pad shall extend a minimum of 4 feet from the front of switchgear/switchboard’s weatherproof enclosure. Confirm pad dimensions with local inspector prior to forming pad to ensure any local code interpretations/conditions are met regarding housekeeping pads.
4. All housekeeping pads located in, on or attached to a building shall be seismically braced/connected to the building structure.

END OF SECTION 26 00 00

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SECTION 27 41 00 - AUDIOVISUAL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. This specification shall apply to all phases of Work hereinafter specified, shown on Drawings, or as required to provide a complete installation of Audiovisual Systems as shown in the plans and specifications for this Project. Work required under this specification, may not be limited to just the Audiovisual Systems (AVS) - refer to Architectural, Electrical, Structural, Landscape, Structural Cabling and Mechanical/Plumbing Drawings, as well as all other drawings applicable to this project, which designate the scope of work to be accomplished. It is the intent of the Drawings and Specifications for the Contractor to finalize design, provide and install a complete, fully operational, and tested system.

1. Work Included. Furnish labor, material, services, and skilled supervision necessary for the construction, erection, installation, connections, testing, and adjustment of all AVS equipment specified herein, or shown or noted on Drawings, and its delivery to the Owner complete in all respects functional system ready for use.

a. Equipment and materials as indicated on the audio-visual drawings.

b. Extension rings where required to provide a flush mount surface for cover plate mounting on finished walls.

c. Engraved nameplates on the equipment rack and any custom wall plates.

d. Coordination of all millworks mounting of any AVS device with the Architect and millwork providers.

e. Include work not usually shown or specified, but necessary for proper installation and operation of the system or piece of equipment.

f. All conduits, device junction boxes, wall plates and floor boxes, not shown on the electrical drawings, but required to complete the audio-visual system installation.

g. Installation of any specialty back boxes, including display backboxes, and speaker rough-in kits with j-boxes and flexible conduit connections.

h. Installation of all backing or structural support for flat panel displays, projectors, projection screens, speakers, and other AVS equipment not shown elsewhere in these drawings and specifications but required to complete the audio-visual system installation.

i. Seismic and safety wires where required.

j. Connection of AVS equipment to Fire Alarm shunt wiring as required to mute AV systems during fire alarm event.

k. If not provided by others, Design, engineer and provide complete means of support, suspension, attachment, and seismic restraint for all AVS equipment,

including but not limited to, speakers, displays and projectors. (Hereinafter "support") of the Work of this Specification in accordance with local building codes and regulations. The contractor shall obtain the services of an engineer licensed to perform this work within the State of Jurisdiction it is to be performed.

2. The AVS Contractor Work shall include installation or connection of certain materials and equipment furnished by others. Verify installation details, installation, and rough-in locations from the actual equipment or from the equipment shop drawings.

3. Audiovisual Systems are diagrammatic, and are intended to convey the scope of work, indicating intended general arrangement of equipment. Follow Drawings in laying out Work and verify spaces for installation of materials and equipment based on actual dimensions of equipment furnished.

B. All miscellaneous system components including, but not limited to, cables, speakers, signal converters, interface panels and components, termination equipment, patch panels, backboards, converters, digital matrix switchers, digital video extenders, controllers, digital signal processors, amplifiers, pre-amps, custom faceplates, mounting hardware, fasteners, racks, cabinets, and any other related items shall be furnished and installed complete under this section, such that the system shall perform all functions listed herein in compliance with all of the specified requirements. Verify functionality of all signal chains for proper operation.

1.2 QUALITY ASSURANCE

A. Design, manufacture, testing and method of installation of all apparatus and materials furnished under the requirements of these specifications shall conform to latest publications or standard rules of the following:

1. AES - Audio Engineering Society

2. ANSI - American National Standards Institute

3. BICSI - Building Industry Consulting Service International, Inc.

4. CEDIA - Custom Electronic Design and Installation Association

5. EIA - Electronic Industries Alliance

6. FCC - Federal Communications Commission

7. HDMI Licensing, LLC

8. AVIXA

9. IEEE - Institute of Electrical and Electronic Engineers

10. ISO - International Organization for Standardization

11. ITU -Telecommunication Standardization Sect

12. MPEG - Moving Picture Experts Group

13. NAB - National Association of Broadcasters

14. NEC - National Electrical Code

15. NEMA - National Electrical Manufacturers Association

16. NFPA - National Fire Protection Association

17. NSCA - National Systems Contractors Association

18. CALOSHA - Occupational Safety and Health Administration

19. SMPTE - Society of Motion Picture and Television Engineers

20. TIA - Telecommunications Industry Association

21. IBC - International Building Code

22. UL - Underwriters Laboratories Inc.

23. VESA - Video Electronics Standards Association

24. Local Authority Having Jurisdiction (AHJ) Published Standards and Codes

B. The contractor is required to obtain the latest revisions of these standards and provide the infrastructure which meets the most stringent implementation of these standards.

C. Perform Work in accordance with the National Electrical Code, applicable building ordinances, and other applicable codes, hereinafter referred to as the "Code". The Contractor shall comply with the Code including local amendments and interpretations without added cost to the Owner. Where Contract Documents exceed minimum requirements, the Contract Documents take precedence. Where code conflicts occur, the most stringent shall apply unless variance is approved.

1. Comply with all requirements for permits, licenses, fees, and codes. The Contractor, at Contractor's expense, shall obtain all permits, licenses, fees, special service costs, inspections and arrangements required for Work under this contract, unless otherwise specified.

2. Comply with the requirements of the applicable utility companies serving this Project. Make all arrangements with utility companies for proper coordination of Work.

1.3 GENERAL REQUIREMENTS

A. Warranty: Furnish a written guarantee for a period of (1) one-year from date of acceptance. Provide Phone Contact information for service personnel within twenty-four hours of call and for exchange of faulty equipment. This obligation is limited to exclude conditions of misuse.

B. The one-year warranty also includes any software installed on the system. After AVS certification and acceptance, source code changes and/or additional programming,

whether requested by the Owner or performed by the Installing Contractor, shall be warranted by the Installing Contractor for a period of one (1) year, with the Installing Contractor responsible for the diagnosis and repair.

C. The Contractor shall provide an annual "Software Maintenance" contract for consideration. This shall cover all software provided as part of this system and/or written for this system and shall include both routine upgrades to applications and operating systems, as well as any modifications to software that may be required by any of the AVS equipment provided on the project. The Software Maintenance contract shall commence immediately after the expiration of the warranty period and continue for three (3) years.

D. Wherever a discrepancy in quantity of equipment, cable, devices, etc., (all materials), arises on the Drawing and/or Specifications, the Contractor shall be fully responsible for providing and installing all material and services required by the strictest condition noted on Drawings and/or in Specifications to ensure complete and operable systems as required by the Owner and Engineer.

E. The Contractor shall hold a valid State of California C-7 Low-Voltage license, shall have completed at least 10 projects of equal scope, shall have been in business of furnishing and installing systems of this scope and magnitude for at least five years, and capable of being bonded to assure the owner of performance and satisfactory service during the guarantee period.

F. The contractor shall hold all other licenses required by the legally constituted authorities having jurisdiction over the work.

G. All work shall be performed under the supervision of a company accredited by the AVS equipment manufacturer and such accreditation must be presented at the time of the bid.

H. The installing contractor shall be a factory authorized dealer and installer for the brand of equipment offered at the time of the bid and shall maintain a fully equipped service organization capable of furnishing adequate repair service to the equipment at time of bid.

I. The equipment in this specification shall be furnished and installed by Authorized Factory Installation technicians. The Contractor shall furnish a letter from the manufacturer of all major equipment, which certifies that the installing contractor is the Authorized Installer and that the equipment has been installed according to factory intended practices. The Contractor shall also furnish a written guarantee from the manufacturer that they shall have a service representative assigned to this area for the life of the equipment.

J. All AV systems supplied equipment shall be listed by Underwriters Laboratories or Nationally Recognized Testing Laboratory. A copy of the listing card for the proposed system shall be included with the contractor's submittal. Any equipment submitted that is not NRTL-listed shall be subjected to on-site testing by AHJ-approved agency at the Contractor's sole cost. All expenses related to such testing, including any repairs or replacements caused by damage to the equipment shall be borne by the Contractor.

K. Personnel: Use adequate numbers of directly employed skilled technicians and installers who are thoroughly trained and experienced with the specified requirements

and the methods needed for proper performance of the AV systems installation work specified herein. Use of temporary labor or sub-contracted labor shall not be allowed unless explicitly allowed elsewhere in this specification.

1. Designated Project Engineer: Provide a designated Project Engineer in responsible charge of the Design, CAD, In-House testing and on the on-site commissioning of the Project during all phases of the work of this specification. The Project Engineer shall hold a current InfoComm CTS-D along with all applicable AV equipment manufacturer certifications necessary to complete the work specified herein. The Project Engineer shall be the same individual through the execution of the work unless illness, loss of personnel, or other circumstances reasonably beyond the control of the Contractor intervene. All Certifications shall be held by the Project Engineer at the time of the bid and shall have at least five (5) years direct experience in similar work.

2. The Lead Technician shall have at least three (3) years' direct experience in similar work. The AV technician assigned to this project shall be fully trained, qualified and carry valid and current industry certifications regarding the installation, operation and testing of audiovisual systems. At least one lead technician shall hold a current InfoComm CTS-I, with all applicable AV equipment manufacturer certifications necessary to complete the work specified herein shall be assigned as Lead Technician to the project. All Certifications shall be held by the Lead Technician at the time of the bid.

3. Custom Control System Programmer: Provide Manufacturers Certifications as required for the equipment used on this project. Provide at least one (1) full-time programmer on staff, capable of on-site custom programming of the custom remote-control system specified herein. Control System Programmer to hold the following certifications: InfoComm CTS-D, CTS-I or CTS along with Extron Control Professional (ECP) Certification, and Extron AV Associate certifications, or Crestron Master Programmer, at least Silver Level., or equivalent Certification from AMX, QSC Level 2. A programming Sub-Contractor may be used as long as the Programmer has the certifications listed above. The AV Contractor shall take full responsibility to provide a properly programmed AV System.

4. Designated Project Manager: Provide Manufacturers Technician's Certifications as required for the equipment used on this project. Provide a designated Project Manager in responsible charge of the fabrication shop and on the Project Site during all phases of installation and testing of the work of this specification. The Project Manager shall hold current InfoComm CTS-D, CTS-I or CTS, and Extron AV Associate certifications or applicable and equivalent Certifications for Crestron or AMX, QSC Level 2 and shall be the same individual through the execution of the work unless illness, loss of personnel, or other circumstances reasonably beyond the control of the Contractor intervene.

5. Commissioning Personnel shall have a current AQAV Certified Quality Technician (CQT) certification in good standing and shall be capable of performing AV commissioning tests during staging and final commissioning of the system according to the AV 9000: Quality Management System for the Audio-Visual Technology Industry.

L. All the equipment in this specification shall be furnished and installed by the Authorized Factory Installer of the equipment with the most current software & firmware package

available at the time of installation.

M. Software – Control System, DSP, and All Other Applicable Equipment

1. At the time of Owner Acceptance of the installation, all equipment shall include all updated software or hardware revisions including source code to allow the Owner to make alternations and modifications to AVS programming to include but not limited to all custom programs for remote control system touch panels, control systems, Digital Signal Processors. The software developer shall retain intellectual property rights to the operating software. The Owner shall be granted a license in perpetuity for use. The following requirements shall apply:

   a. A written release shall be given by the Installing Contractor for all control programming done by the Installing Contractor's personnel or sub-contractors. The release shall acknowledge the Owner's ownership and right to modify programming directly, or to have the or to have the programming modified by others on the Owner's behalf. The programming code provided must be the latest version. Provide a date in the code file name.

   b. No program resident in a control system shall be overwritten until a back-up of the resident program is made or programming modified by others or the owners' behalf.

   c. All source code changes must be fully documented.

   d. At the completion of the project, (3) USB drives shall be supplied to the Owner with the written release that includes the program and source code for the system in an unencrypted format. All documentation, not residing in the code in Adobe PDF and Microsoft Office format. The programming code provided must be the latest version. Provide a date in the code file name.

N. Verifying Drawings and Job Conditions:

1. This Contractor shall examine all Drawings and Specifications in a manner to be fully cognizant of all work required under this Section.

2. This Contractor shall visit the site and verify existing conditions. Where existing conditions differ from Drawings, adjustment(s) shall be made, and allowances included for all necessary equipment to complete all parts of the Drawings and Specifications.

O. Operation, Control Programming and Touch Panels

1. It is imperative for the AV Contractor to interview the Owner's staff to gather and document the various operational modes including signal routing of the DSP-Control System, IP Video Systems, and Device Control Requirements to ensure any controlled device is properly integrated into the Control system. Control via the QSC Touch Panels, Control Room Computer and other Existing System must be integrated as required.

1.4 WORK IN COOPERATION WITH OTHER TRADES

A. Examine all project Drawings and Specifications to determine how work performed by

the architectural, structural cabling, electrical, mechanical, structural, and other trades affect the AVS systems. Provide the type and amount of AVS materials and equipment necessary to place this work in proper operation, completely wired, tested and ready for use. This shall include all additional conduits, boxes, and other devices for the required operational sequence of all AVS equipment.

B. Low voltage conduit, standard back boxes and power will be provided by division 16 or 26000 contractors.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver equipment until the site conditions are adequate to receive work; protect items from weather while in transit.

B. On-Site Storage

1. The Contractor shall be responsible to coordinate and maintain a secure storage space.

2. If this storage space is required to be on-site it shall be the Contractor's responsibility to coordinate the size and spatial requirements with the Owner.

3. The Contractor shall assume full responsibility for the storage space and all contents, unless otherwise indicated by the Owner.

4. The Contractor shall examine the site and the Programmatic Documents and review with the Owner the designated areas of access, delivery, and storage for the Contractor's use. The Contractor agrees that such areas are satisfactory and sufficient for their needs in the completion of their work and in conformance with the terms of this Contract.

C. Store materials indoors in ventilated areas with constant, but minimum temperature of 60 degrees F and a maximum temperature of 90 degrees F and maximum relative humidity of 25% to 55%.

D. Protection from Damage

1. The Contractor shall provide all protection necessary to safeguard their work from damage by their operations and the operations of others. Unless the Contractor proves to the Owner’s satisfaction that the Work has been damaged by others, the Contractor shall promptly repair, adjust, and clean all defective installations and bear all associated costs.

1.6 RECORD DRAWINGS

A. Drawings of Record:

1. The Contractor shall provide and keep up to date, a complete record set of drawings. These shall be corrected daily and show every change from the original Drawings. This set of prints shall be kept on the job site and shall be used only as a record set. This shall not be construed as authorization for the Contractor to make changes in the layout without written direction in each case. Upon completion of the work, a set of reproducible Contract Drawings shall be used to

denote all changes as noted on the record set of prints shall be incorporated thereon with black ink in a neat, legible, understandable, and professional manner. Refer to the Supplementary General Conditions for complete requirements.

1.7 APPROVALS, EQUALS, SUBSTITUTIONS, ALTERNATIVES, NO KNOW EQUAL

A. Approvals: Where the words (or similar terms) “approved”, “approval”, “acceptable”, and “acceptance” are used, it shall be understood that acceptance by the Owner, Architect and Engineer are required.

B. Equal: Where the words (or similar terms) “equal”, “approved equal”, “equal to”, “or equal by”, “or equal” and “equivalent” are used, it shall be understood that these words are followed by the expression “in the opinion of the Owner, Architect, and Engineer.” For the purposes of specifying products, the above words shall indicate the same size, made of the same construction materials, manufactured with equivalent life expectancy, having the same aesthetic appearance/style (includes craftsmanship, physical attributes, color and finish), and the same performance and function.

C. Substitution: For the purposes of specifying products “substitution” shall refer to the submittal of a product not explicitly approved by the construction documents/specifications.

1. Substitutions for specified equipment shall be submitted and received by the Engineer ten (10) days prior to the bid date for review and written approval. Regulatory Agency approval for all substitutions shall be the sole responsibility of the Contractor. To receive consideration, requests for substitutions must be accompanied by documentary proof of its equality with the specified material. Documentary proof shall be in letterform and identify the specified values/materials alongside proposed equal values/materials. In addition, catalog brochures and samples, if requested, must be included in the submittal. ONLY PRE-BID APPROVED PRODUCTS, ISSUED VIA A FORMAL BID ADDENDUM TO ALL BIDDERS, WILL BE ALLOWED ON THE PROJECT. REGARDLESS OF THE APPROVAL ON ANY SUBSTITUTION, ALL BIDS SHALL BE BASED ON THE PRODUCTS EXACTLY AS SPECIFIED. PRICING FOR EACH APPROVED SUBSTITUTION SHALL BE INCLUDED IN THE BID SUBMITTAL AS A SEPARATE LINE ITEM.

2. If the Contractor proposes to substitute the specified speaker system(s), the Contractor shall be responsible to provide the Owner & Engineer with an AMFG Electronic and Acoustic System Evaluation and Response Analysis (EASERA) model depicting equal or better performance in both uniformity of direct field response and Speech Transmission Index (STI) as compared to the specified speaker system.

3. In the event that written authorization is given for a substitution after award of contract, the Contractor shall submit to the Engineer quotations from suppliers/distributors of both the specified and proposed equal material for price comparison, as well as a verification of delivery dates that conform to the project schedule.

4. In the event of cost reduction, the Owner shall be credited with 100 percent of the reduction, arranged by Change Order.

5. The Contractor warrants those substitutions proposed for specified items shall fully perform the functions required.

D. Alternates/Alternatives: For the purposes of specifying products, “alternatives/alternates” may be established to enable the Owner/Architect/Engineer to compare costs where alternative materials or methods might be used. An alternative price shall be submitted in addition to the base bid for consideration. If the alternate is deemed acceptable, written authorization will be issued.

E. No Known Equal: For the purposes of specifying products, “No Known Equal” shall mean that the Owner/Architect/Engineer is not aware of an equivalent product. The Contractor will need to submit a “Substitution” item, per the requirements listed above, if a different product is proposed to be utilized.

1.8 SHOP DRAWINGS/SUBMITTALS

A. Shop Drawings/Submittals shall be submitted within 20 working days of a notice to proceed, in digital sets accompanied by Letter of Transmittal, which shall give a list of the number and dates of the drawings submitted. Drawings shall be complete in every respect and bound in sets.

B. The Shop Drawings/Submittals submitted shall be marked with the name of the project, numbered consecutively, and bear the approval of the Contractor as evidence that the Contractor has checked the Drawings. Any Drawings submitted without this approval will be returned to the Contractor for resubmission.

C. If the shop drawings show variations from the requirements of the Contract because of standard shop practice or other reasons, the Contractor shall make specific mention of such variations in the Contractor’s letter of transmittal. If the substitution is accepted, the Contractor shall be responsible for proper adjustment that may be caused by the substitution. Samples shall be submitted when requested.

D. Only products listed as “Equal” within the contract documents, along with formally approved “Substitutions” will be reviewed. Products not conforming to these items will not be reviewed and will be returned to the Contractor for re-submittal.

E. Review comments used in response to shop drawings/submittals are:

1. “No Exception Taken” - Product approved as submitted.

2. “Furnish as Corrected” - Re-submittal not required, although the Contractor shall provide the submitted product with corrections as noted.

3. “Revise and Resubmit” - Re-submittal required with corrections as noted.

4. “Rejected” - Re-submittal required based upon the originally specified product.

F. Original, Contractor provided shop drawings shall be submitted on the following but not limited to: Note: AutoCAD or Revit backgrounds will be provided.

1. Audio, Video, and Control System one-line diagrams with cable type and cable numbering provided.

2. AV Equipment Rack Elevations

3. AV Floor, Ceiling and Elevation Plans.

4. Control Panel & Touch Panel screen layouts.

5. AV equipment attachment drawings with structural engineer's stamp if required.

6. All other products called out on drawings that call for shop drawing submittal.

G. All equipment specified and/or required for a complete and operational AV and Control system shall be listed in the projects equipment list submittal.

1. Provide the AV and Control equipment list divided into room/area sections with the AV device Manufacturer in alphabetical order.

2. For Example:

a. Classroom 125

1) Extron TLP1025 Touch Panel

2) FSR PL-500 Floor Box.

1.9 MAINTENANCE, SERVICING, INSTRUCTION MANUALS AND WIRING DIAGRAMS

A. Prior to final acceptance of the job, the Contractor shall furnish to the Owner at least four (4) copies of operating and maintenance and servicing instructions, as well as four (4) complete AV System wiring diagrams for the following, but not limited to items or equipment:

1. Audio, Video, and Control Systems.

2. Rack Elevations.

3. Touch panel layout pages.

4. Current Programming source code.

B. All wiring diagrams shall specifically cover the system supplied. Typical drawings or consultants supplied drawings will not be accepted. Four (4) copies shall be presented to the Owner.

PART 2 - SYSTEM EQUIPMENT SPECIFICATION

2.1 MATERIALS

A. Materials and Equipment: All AVS materials and equipment, including custom-made equipment, shall be new and shall be listed by Underwriter's Laboratories (UL) and bear their label or be listed and certified by a Nationally Recognized Testing Lab (NTRL) that is also recognized by the local Authority-Having-Jurisdiction (AHJ).

B. Frequency Coordination. Prior to ordering equipment, the Installing Contractor shall

coordinate the frequencies of all wireless devices to prevent unwanted interaction between devices and rooms. This includes, but is not limited to, wireless microphones, assisted listening system devices, wireless control panels, etc. Verification of Frequency coordination shall take place with the use of a spectrum analyzer and frequency allocation/analysis software.

2.2 SYSTEM FUNCTIONS AND CAPABILITIES:

A. The AVS (If applicable) shall be utilized for presenting, viewing, and listening to multimedia presentations. The system shall utilize/integrate where indicated, computer, microphone, and other inputs for output to the Video Projector, LCD/LED Displays, and Sound Reinforcement Systems. The AV system shall be controlled by a Touch Panel interface with DSP system processors. The control system will be able to control the required functions of the AV equipment, audio volume, audio switching, paging, and control. See AV drawings for more detailed information regarding specific system functionality.

B. The AVS shall provide clear, natural sound uniformly distributed throughout the designated areas. The system shall utilize speakers as shown on the plans. The AV system shall also be able to display High-Definition Video to the Native Resolution of all displays without any distortion or artifacts.

C. The system shall have adequate dynamic range without audible clipping or distortion to accommodate all types of program material. Audio and Digital Signal Processing shall be employed in the designated rooms to ensure smooth frequency response, high acoustical gain before feedback. When at maximum level, the system shall operate without audible distortion, rattles, and buzzes. All switching shall be silent and without pops and or transients.

D. The system's frequency response shall:

1. Be within +/- 1.5 dB from a curve which is flat from 80Hz to 10 kHz.

2. There shall be a minimum 12dB per octave roll-off below 32 Hz.

3. Uniformity of coverage of the system at seated ear height (42") shall be within +/- 1.5dB in the 4 kHz 1/3 octave band at any seat location using pink noise as a test signal.

E. System noise shall not exceed an equivalent input noise of -120dB based on a 20 KHz-noise bandwidth. The predominant noise component in the system output under any operating condition shall be that of the input stage.

F. The sound level capability of program material levels produced in all seats shall be at least 98 dB when measured with a scaled filter, set at "C Weighting". There shall be at least 6dB of amplifier headroom.

G. The system shall provide clear audio to all areas covered by the system. All side, Left & Right and any stage lip, or under balcony speakers shall be wired discretely to the correct channel on the amplifier. See AVS drawings for exact location.

H. EDID and Color Space Management. EDID data exchange is a standardized means for a display to communicate its capabilities to a source device. It is the AVS

contractor's responsibility to address and resolve and manage all EDID and Color Space issues.

I. HDCP (High-bandwidth Digital Content) is an encryption protocol for copy protected video content such as Blu-Ray Disc, HD movie downloads, Cable TV & Satellite TV. It is the Contractor's responsibility for proper HDCP 2.2 and Digital Rights Management (DRM) in all systems listed in plans and this specification. This shall apply to all HDMI, DVI or Display Port signals. HDCP is not applicable to SDI signal lines, and no attempt to pass encrypted material through these signal paths shall be attempted.

J. CEC (Consumer Electronics Control) is device control functions between all connected HDMI devices. It is the AVS contractor's responsibility for proper CEC Management in all systems listed in plans and this specification.

2.3 SOFTWARE PROGRAMMING

A. General: Except when otherwise agreed in writing the client shall retain legal and beneficial ownership of all Intellectual Property, including source code, created by the Contractor, their employees, and subcontractors.

B. The Contractor must allow sufficient time for the programming of all software configurable audio, video, and control systems. Contractors must evaluate the system's functional requirements and user interface and then allow time in their bid accordingly. The system description as well as the end user interview will provide the Contractor with the necessary information needed to proceed with the programming. Any questions as to the system's functional requirements must be sent in written RFI form to the Consultant. All programming schemes must be submitted to the Consultant for approval before programming starts. This includes the appearance of all user interfaces, touch panel layouts, preset and sub-preset information (acquired through client interviews), and speaker control schemes. The Contractor shall also submit a narrative for the control system concept to the Consultant for approval. The Contractor is to interview the Owner and their representatives to acquire the necessary information needed to allow for the proper programming of this system. The Contractor, after interviewing the Owner, shall then submit a written report stating his interpretation of the client's requirements for approval by consultant. Only after the Client and Consultant have approved the programming report may the Contractor proceed with the programming of this system.

C. If Applicable, equipment that is connected to the Client's local area network and is configurable via the local area network must have its equipment software installed onto dedicated computers provided by the Client. The Contractor is to allot time to install and test equipment software onto a minimum of two of the Client's computers which are to be identified by the Client and/or Consultant. The computers shall be programmed to emulate user interfaces throughout the facility. The Contractor shall coordinate all software deployment over IP with the Client's Information technology department.

D. A user-friendly/easy to use graphical interface programmed by the Contractor shall allow for easy operation of the system. This interface shall allow novice users the control of the system components without having to access the digital schematic diagram. These main system components shall include master volume control, zone volume control, room combining, routing, switching, source-equipment level control and any other control necessary for the system to function properly from a user standpoint.

E. AV Contractor shall provide a “refresh” of the programming after 6 months, or another agreed to duration where the users will provide a detailed list of programming changes. This includes code and control panel changes. Many times, as the users operate the AV control system needed changes become apparent. The AV contractor must provide a minimum of 15 hours for this work, including loading and testing the program changes. Any reasonable added cost for this work shall be an added cost to the client. The AV design team will review the added cost for confirmation.

F. Control system minimum programming outlined below:

1. The Contractor shall allot as many hours as required for on-site control system programming with the Client’s representative.

2. The Control System in this project may connect to the Client’s Local Area Network (LAN). This connection will provide desktop computers control of the audio-visual system as well as make available remote troubleshooting via the internet and (If applicable) Extron Global Configurator Plus and/or Global Configurator Professional. The Contractor shall provide time to install control system interface software on at least three desktop computers. Coordinate work with Client’s Information Services personnel.

3. Provide password protection to each control surface in this facility as required by the owner.

4. As required by the owner touch panels shall be activated and deactivated by password. Upon start up a password dialog box shall be presented to the user to enter his/her password. Only after entering a password will the user have access to the system. The system shall be programmed to shut down automatically after being idle for a time to be specified by the user.

5. Touch panel layout design shall conform to the InfoComm International “Dashboard for Controls” and programming guidelines. Touch panel designs are to be custom to this project. Re-purposed touch panel designs are not acceptable.

6. Control Help File: Each touch panel shall include a help file that will explain each layer of the touch-panel control scheme.

7. The control system shall utilize help desk software to provide:

   a. Real-time monitoring (If Possible) of: Control system, Device monitoring, Projector lamp life, System online status, Room activity, Remote system diagnostics via Contractors help desk, Remote system control, Fault reporting via email alert, Logging of help request, User access control via password protection, Event logging, report and chart generation.

8. All serial-controlled devices must have bi-directional communication with the control system. All control functions locally available on each device must be accessible via the remote-control system. All locally gestured control functions must be mirrored on the control system user interface. In other words, if a volume control is adjusted on a DSP interface that adjustment must register on the control interface.

9. The control system shall be used to power up and down connected equipment if

required.

10. If applicable all projectors shall be monitored and report lamp hours remaining and lamp failure if required.

G. Complexity of Programming:

1. It is required that the Contractor be experienced in the specified Control System. and shall have experience in Professional programming and programming systems of this complexity. Contractors shall allow enough time in their bid to permit extensive programming of all software configurable audio, video, and control systems to the requirements of the client and consultant. The contractor shall break out cost associated with programming of these systems for review by the Consultant. By submitting this bid, the Contractor agrees that they understand systems of this type and that all programming services are included to the satisfaction of the Owner and Consultant. The Contractor further agrees that they shall not make any claim for additional monies because of misinterpretation of programming requirements.

2. It is imperative for the AV Contractor to interview the user's staff to gather and document the various operational modes including signal routing of the DSP-Control System, IP Video Systems and Dante Device Control Requirements to ensure any controlled device is properly integrated into the Control system. Control via the QSC Touch Panels, Control Room Computer and other Existing System must be integrated as required.

3. The Dante Network may be quite extensive, and Dante Controller must be labeled and organized. Dante routing presets will be provided, as necessary.

4. The IP Video and all AV network switches must be configured properly for trouble free operation. Pay particular attention to the IP Video network switch programming. Proper switch CONFIGURATION and VLANS MUST be provided as required.

H. Control System Programming. Minimum Touch Panel Functions. Coordinate all functional programming with the owner before final programming sign off.

2.4 PROJECT AUDIO VISUAL SYSTEM DESCRIPTION

A. Description

1. Provide Audio – Visual and AV control systems as shown in the contract drawings. Provide a complete and operable AV and Control System.

2.5 AUDIO/VISUAL SYSTEM PRODUCTS

A. The products listed shall be the minimum quantity, performance, functionality, and quality levels. If additional and/or upgraded components are required to meet the performance requirements of this final design-build specification, the contractor shall include all costs for such added and/or upgraded components in the base bid.

2.6 GENERAL PRODUCTS FOR SYSTEMS

A. SEE SHEET XXX FOR MAJOR EQUIPMENT LIST.

1. PROVIDE ALL REQUIRED COMPONENT FOR A COMPLETE OPERATIONAL AV AND CONTROL SYSTEM AS DESCRIBED IN THIS DOCUMENT AND ON THE AV DRAWINGS

2.7 ASSISTIVE LISTENING SYSTEMS

A. SPECIFICATIONS

1. SEE SECTION 27 51 00

2.8 CABLE – ALL SPACES

A. Speaker Cable, 70-Volt distribution, Plenum Rated 2-Conductor, 14 AWG, unshielded pair: Extron, West Penn, Belden or equal.

B. Loudspeaker Cable Plenum Rated 2-Conductor, 12 AWG, unshielded pair: Extron, West Penn, Belden or equal.

C. Loudspeaker Cable Plenum Rated 2-Conductor, 14 AWG, unshielded pair: Extron, West Penn, Belden or equal.

D. Analog Microphone/Line Level Installation Cable, 22 AWG conductor, jacketed, shielded, twisted-pair, Plenum Rated: Extron, West Penn, Belden or equal.

E. Control System Device Control (RS232, Relay or Contact Closure): (Dual 22 AWG shielded twisted pairs with individual drain wires, each pair is color-coded Red/Black and Green/White to simplify identification.) Plenum Rated: Extron, West Penn, Belden or equivalent.

F. Data Network: Plenum-rated Category 6, see Structured Cabling Specifications for additional requirements.

G. Serial Digital Interface Cable RG6/U, 75 Ohm Coaxial Cable Belden 4694R or equal. 12G-SDI up to 258'. Provide the correct BNC connector for the specified cable. Provide 12G-HD-SDI extension if cable runs are longer than 225'.

H. Provide plenum rated cables for all cables where required by code. Any cable changes or substitutions must be submitted and approved prior to installation. Non-compliant cable that has been installed without approval shall be replaced at the Contractor's expense.

I. Fiber, OM4. MM, 50 micron / 6 strand or strands as required.

J. Video over IP, CAT6 Belden, West Penn or equal.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION DESCRIPTION

A. The installation, configuration and wiring of the system shall be executed in accordance with the drawings and the equipment manufacturer's installation instructions and

guidelines. Should any variations in these requirements occur, the Contractor shall notify the architect before making any changes. It shall be the responsibility of the factory-authorized installer of the approved equipment to install the equipment and guarantee the system to operate as per plans and specifications.

B. Workmanship on the installed systems shall be of professional quality, best commercial practice and accomplished by persons experienced in the techniques and standards of the industries involved.

C. Furnish all Additional conduits, AV Back-boxes, conductors, equipment plugs, terminal strips, etc., and labor to install a complete and operable system.

D. The cables within the rack or cabinets shall be carefully cabled and laced with Velcro wraps. All cables shall be numbered for identification. Cables should have enough slack to allow the removal of equipment for service without having to cut multiple Velcro ties or wire wraps. Power plugs need to be labeled at PDU.

E. Splices of conductors in underground pull boxes are not permitted.

F. All communications cabling used throughout this project shall comply with the requirements as outlined in the NEC Articles 725, 760, 770, and 800 and the appropriate local codes. All copper cabling shall bear UL listed type CMP (Plenum Rated) and/or CM/G (General Purpose) and/or CMR (Riser Rated). All fiber optic cabling shall bear OFNP (Plenum Rated) and/or OFNR (Riser Rated) and/or OFN/G (General Purpose). Contractor is responsible for installing an appropriately rated cable for the environment in which it is installed.

G. The Contractor shall thoroughly clean all equipment and materials. All exposed parts of the equipment, cabinets, and other equipment shall be left in a clean condition, unblemished and free of all dirt, dust, smudges, spots, fingerprints, etc., The Contractor shall remove all debris and rubbish occasioned by the work from the site. The Contractor shall thoroughly clean all buildings of any dirt, debris, rubbish, marks, etc., Caused by the performance of this work.

H. The Conduit System. Each conduit shall contain wires or cables of the same signal level or the same type of circuitry only. Low Level Lines, medium level lines, video level lines, high level lines and data and control circuits should be run in their respective separate conduits.

I. Wiring and Cabling. During installation both ends of all single wires or cables shall be marked with consecutive approved number markers, and a careful running log kept of route and terminations. After attachment at terminations these markers shall be accessible and readable for identification. A detailed wiring diagram shall be furnished with these numbers shown. At the operational level (i.e., Audio-Visual equipment receptacle boxes, etc.) all receptacles shall be clearly marked by function and number (when there are many of the same function). For example, where a given microphone line may appear at several locations, the same label shall show.

J. Power distribution cables shall not be installed adjacent to signal cables. Power distribution cabling shall be on the opposite side of the equipment enclosure from signal cables and shall be uniformly located throughout the installation.

K. Wherever signal lines entering the equipment areas must be connected into the racks,

the use of intermediate terminal strips shall be used. This shall also facilitate the testing of maximum increments of the systems in the Contractor's shop. UTP Cables shall terminate in a Patch Panel and / or Switch. All connections of lines at terminal strips, as well as at signal receptacles, shall be mechanically secured and then soldered. No unsoldered connections shall be permitted.

L. Where lines approach the racks and terminal strips, they shall also be mechanically anchored at the rack, and provided with sufficient slack length to avoid strain, abrasion, or wear. All cable entry shall be through the tops of racks or through entrance holes in the base of the rack. No cable shall enter racks through front, rear, or side panel openings. For equipment mounted in drawers or on slides, the interconnecting cables shall be provided with a service loop of appropriate length. Cables shall not protrude from the back of racks. All system wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means.

M. System Grounding.

1. The "spider" concept is designed to avoid ground loops and inductive coupling.

2. The systems shall be hum free, stable, and free of oscillation with the earth ground temporarily disconnected.

3. The earth ground shall be made at only one point in the system as indicated and shall be in accordance with National Fire Protection Association 70-2014.

4. The grounding method shall ensure that the system is free of the following problems under any mode of operation:

   a. RF oscillation, pickup, and interference.

   b. Distortion.

   c. Crosstalk.

   d. Signal Leakage.

   e. Very high frequency feedback.

   f. Audio Hum.

5. The equipment racks shall be isolated from, and not electrically connected to, the building grounding system. This means that the conduit system shall not be electrically connected to the equipment racks and that the equipment racks shall be installed so that they are electrically isolated from the building structural steel. The racks shall be electrically connected at only one point to the isolated grounding system.

6. To ensure the least amount of cable un-twisting, it is required that all cables shall be stripped using a special tool.

7. The use of lubricants (i.e., Yellow 77) to facilitate the installation of cables in conduits is highly discouraged. If such a lubricant must be used, the Contractor

shall verify the acceptability of the lubricant to be used with the cable manufacturer, prior to using such a lubricant.

8. Under no circumstance are "channel locks" or other pliers to be used.

9. Plenum rated cable may be run exposed above ceilings, provided the cabling is supported independent of other utilities such as conduits, pipes, and the ceiling support systems. The cables shall not be laid directly on the ceiling panels. The use of cable ties shall be done in accordance with the cable manufacturer's requirements. The cable jacket composition must meet local and all other prevailing fire and safety codes.

N. Labeling

1. Wiring Labels: At all connection points for all types of cable & wiring, a label strip shall be attached indicating the name/number of that cable or wire as follows:

a. At internal locations (inside racks, cabinets, or boxes), a pressure sensitive label shall be used.

b. At external locations, a printed label covered with clear shrink wrap or approved labeling system shall be used.

2. Equipment Labels: All active components shall have labels at the front and rear. Labels shall be applied plumb and neat and shall not cover any equipment lights, recessed controls, or control labels.

a. Front labels shall indicate functional use of equipment.

b. Rear labels shall indicate system schematic reference designation.

3.2 PERFORMANCE TESTS OF THE COMPLETE SYSTEM. (SEE SECTION 3.08 FOR FINAL INSPECTION)

A. Verify that all wiring is correctly and completely installed.

B. Verify that the entire system's performance is in accordance with the design requirements.

C. System tests that the Contractor may wish for his own satisfaction, shall have been performed and successfully achieved before observation is requested. The Owner's representative may request repetition and demonstration during observation of certain of these tests or other critical tests if problems become apparent. If specifications are not met, further observations shall be at the Contractor's expense.

D. Sealing of openings between floors, into or through rated fire and smoke walls, existing or created by the contractor for placement of new or removal of old cable into or through shall be the responsibility of the contractor. Sealing material (Approved UL listed system) and application of this material shall be accomplished in such a manner that is acceptable to the local fire and building authorities having jurisdiction over this work. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the contractor's work. Any openings created by or for the contractor and left unused shall also be sealed as part of this work.

E. Firestopping work shall be performed by a single contractor to maintain consistency and accountability on the project.

1. The Contractor shall install penetration firestop seal materials in accordance with design requirements, and manufacturer's instructions.

2. The Contractor's installer shall be certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements.

3. All installed firestops through penetration firestops shall be identified via label, or stencil. Label shall state that the fill material around the penetrating item is a firestop, and that it shall not be disturbed unless by an authorized contractor. The label shall include the firestop brand name, and the classified system number for which it was installed.

4. Sample Label:

a. MANUFACTURER'S NAME

b. ATTENTION

c. Fire Rated Assembly

d. For Any Changes to This System, Please Refer to UL System Listed Below

e. PRODUCT

f. HOUR RATING

g. UL SYSTEM

h. INSTALLATION DATE

i. INSTALLED BY

j. LICENSE NUMBER

k. PHONE

3.3 Equipment Rack and Equipment Testing and Adjusting Procedures

A. Conduct procedures in fabrication shop. Verify safe and proper operation of all components, devices, or equipment, establish nominal signal levels within the systems, and verify the absence of extraneous or degrading signals. Make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, gains and losses, as applicable. Submit test report with color photographs of each equipment rack, front and back. Finally, perform the following procedures:

B. Preliminary: Verify: Grounding of devices and equipment. Integrity of signal and Audiovisual system ground connections. Proper provision of power to devices and equipment. Integrity of all insulation, shield terminations and connections.

C. Integrity of soldered connections. Absence of solder splatter, solder bridges. Absence of debris of any kind, tools, etc. Routing and dressing of wire and cable.

1. All wiring, including polarity and continuity, including conformance with wire designations on running sheets, field and shop drawings.

2. Mechanical integrity of all support provisions.

D. All new equipment racks shall be bolted to the floor/millwork by the Contractor once the Owner determines the exact location for new rack to verify the original Middle Atlantic racks are bolted to floor and seismic bracing are installed to code. The earthquake mounting brackets for each rack kit shall be screwed to studs, not drywall. All equipment shall be serviceable in the rack's final location – the need to unbolt racking equipment to access or service equipment is not acceptable.

E. Cleaning

1. Clean each section or area of where the work was conducted after completion to permit immediate use of the area.

2. Remove and discard all refuse, rubbish, and debris.

3. The Contractor shall ensure that all recyclable and environmentally hazardous waste materials are disposed properly.

4. Make good all existing structures, surfaces, and utilities affected by cutting, coring, mounting, drilling, or other new work.

5. Clean all furnished equipment of dust, dirt, fingerprints, smudge, and other material prior to calling for a Substantial Performance of Work Review or Completion of Work Review.

3.4 PROTECTION

A. During the installation phase and up to the date of achieving Substantial Performance of Work, protect finished or unfinished work against damage or loss. In the event of such damage or loss, immediately replace or repair such work or equipment at no cost to the Owner.

3.5 SPECIFIC SYSTEM INSTALLATION REQUIREMENTS

A. The installer shall, upon completion of the system, orient all antennas and speakers, align all projectors, screens and displays, adjust all controls, etc., to provide a system operating at maximum capability. Submit block diagram and shop drawing of equipment.

3.6 GENERAL TESTING REQUIREMENTS

A. Provide all instruments for testing and demonstrating in the presence of the owner's inspector that all audio, digital video and control parameters are as stated in the factory data sheets. Check all circuits and wiring to verify they are free of shorts and grounds.

1. EQUIPMENT AND COMPONENTS IN NEED OF ADJUSTMENT, REPAIR OR

REPLACEMENT AND DISCOVERED DURING SUCH TESTING, SHALL BE IMMEDIATELY ADJUSTED, REPAIRED OR REPLACED WITH ALL NEW EQUIPMENT AND THAT PART OF THE SYSTEM SHALL THEN BE RETESTED. ALL SUCH REPLACEMENT OR REPAIR SHALL BE DONE AT NO ADDITIONAL COST TO THE OWNER.

3.7 SPECIFIC AUDIO TESTING REQUIREMENTS

A. Furnish all laptops, software, equipment, and personnel to conduct these tests in accordance with the performance specification requirements. ANSI, AVIXA and EIA Standards.

1. Audio testing and adjustment:

2. Adjust all audio levels. Measure and record absolute impedance at 400 Hz and 1 kHz for each speaker line. Correct polarity of all speaker lines.

3. Each “leg” of every individual speaker line shall be measured using a voltmeter to ensure that there are no shorts to ground.

4. When the system is brought to full power, there shall be no hums, buzzes, rattles, or indication of any abnormal speaker noise.

5. Audio check for continuity, polarity, cold solder connections, shorts and opens.

B. Provide full flat panel monitor display calibration and adjustments for optimal picture quality for a single HDMI input. Provide proper aspect ratio configuration for both 16:9 and 16:10 sources (What about 21:9?). Use a test generator (I.E. Extron VTG or equal): for all setup verification and verify proper image configuration with all inputs. (Contract the Owner’s Technical Representative prior to final adjustment to coordinate).

1. Controls: Adjust all controls to achieve the specified performance. Provide shaft locks or covers for all level controls, as appropriate to prevent unauthorized gain changes. The contractor shall confirm that all control system operations are properly programmed and repeatable.

2. The contractor shall review and assess the appropriate Lens Throw length between all video projectors and the projection screens to ensure optimum picture sizing and focus. Make all adjustments necessary, including projector keystone correction and lens shift to achieve the image size and shape required.

3. Provide full video projector calibration and adjustments for optimal picture quality for all used inputs. Provide proper aspect ratio configuration for 4:3, 16:9 and 16:10 sources. Set all projector configuration presets required for control system recall coordination and provide final system documentation.

4. Testing Report: Provide a letter/report documenting the results of these preliminary tests, including amplifier gain/level settings, DSP EQ filter settings, and AV equalization curves for review by the AV Design Consultant and Owner.

5. The Contractor is fully responsible align, program, and test the sound speaker system to include the left, right, and center arrays as well as subwoofer speakers where these occur, to the respective speaker manufacturer specifications as

required to achieve required uniformity of coverage as specified herein.

6. Contractor shall and utilize provide the following Calibrated Test Instruments as a minimum during commissioning and acceptance testing:

7. Sensitive AC voltmeter, -80dBu sensitivity or more, 20Hz -30KHz response, able to measure signal to noise ratio, THD, electrical levels within the system. Note that some systems require measurements up to 100 volts and may require an external pad.

8. Sound Pressure Level Meter, ANSI Type I with A and C weighting filters, fast or time averaged.

9. Audio Signal Generator, 20Hz-30kHz, sine wave, pink noise, and continuous sine wave sweep.

10. Amplified Loudspeaker 100 mm producing 60 dBa at one meter, and 70 dBa at one-meter, pink noise, sine wave, and speech files.

11. 200Mhz Oscilloscope, with TV sync (analog video only). Analog Signal Generator NTSC/PAL, plus computer patterns at all required resolutions and refresh rates required for the systems under test. For systems with composite video, include Pluge pattern. (Analog video only)

12. Digital Signal Video Generator for computer patterns for all resolutions and refresh rates required for the systems under test, HDMI/DVI/HD-SDI with and without HDCP.

13. The ability to measure STI-PA (source analyzer).

14. Colorimeter/luminance meter, 10% accuracy.

15. Infrared thermometer.

C. Test media with known levels (audio, video, etc.): Cd's, VS, DVD's etc.

1. AD/DC multimeter.

    a. Outlet tester (to test power outlet wiring).

    b. The ability to measure electrical power (watt meter, clamp meter, etc.).

    c. Cable sets, cable assemblies, adapters as required to sample and measure in-or-out of circuit as required.

    d. Computer with Smaart v8 or Systune. Outboard Dual Channel Preamplifier and Calibrated microphones. Earthworks M23 or equal.

    e. All equalization shall be accomplished using FFT Transfer Function. No real-time analysis methodology shall be allowed.

    f. Verification of Frequency coordination shall take place with the use of a spectrum analyzer and frequency allocation/analysis software.

g. Testing Report: Provide a letter/report documenting the results of these preliminary tests, including amplifier gain/level settings, crossover filter settings, and AVS equalization curves for review by the AV Design Consultant.

3.8 SPECIFIC AUDIOVISUAL SYSTEM NETWORK CABLING TESTING REQUIREMENTS

A. Category 6x Cable Testing.

1. The Contractor shall provide competent, factory-trained engineers and/or technicians, authorized by the manufacturer of the cabling system, to technically supervise and participate during all tests for the systems.

2. The Contractor shall test and certify the cabling system to minimum standards as set forth in the ANSI/TIA/EIA-568-C specifications for Category 6A cable as appropriate.

3. General Requirements – Category 6A.

a. Every cabling link in the installation shall be tested for:

1) Wire Map

2) Length

3) Insertion Loss

4) NEXT Loss

5) PS NEXT Loss

6) ELFEXT Loss

7) PS ELFEXT Loss

8) Return Loss

9) Propagation Delay

10) Delay Skew in accordance with the field test specifications defined in ANSI/TIA/EIA-568-C. This document will be referred to as the “TIA Cat 6A Standard.”

b. In addition to testing the “In-link” performance parameters detailed in 3.a above, Alien Crosstalk testing or “Between-link’ testing shall be carried out in accordance with Annex E of the TIA Cat 6A Standard. Alien crosstalk testing includes the PS ANEXT and PS AACR-F (Power sum alien attenuation-to-crosstalk ratio from the far end) performance parameters. The standards refer to the link-under-test for Alien Crosstalk as the disturbed link.

c. PS ANEXT and PS AACR-F shall meet or exceed the limits defined in Section 7.8 of the TIA Cat 6A Standard.

4. The installed twisted-pair horizontal links shall be tested from the Switch located in the equipment rack to all end points throughout the AV System for compliance

with the “Permanent Link” performance specification as defined in the TIA Cat 6A Standard.

5. One hundred percent of the installed cabling links must pass the requirements of the standards mentioned in 3.a above and as further detailed in Section B. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section C below.

6. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs provided by BiCSi or the ACP (Association of Cabling Professionals).

7. The test equipment (tester) shall comply with the accuracy requirements for level IIIe field testers as defined in the TIA Cat 6A Standard. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table I.1 of Annex I of the TIA Cat 6A Standard. (Table I.1 in this TIA document also specifies the accuracy requirements for the Channel configuration.)

8. The test plug shall fall within the values specified in test plug NEXT loss requirements of the TIA Cat 6A Standard.

9. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

10. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

11. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in ANSI/TIA/EIA-568-C). Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.

12. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. To which extent '*' results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.

13. Owner or owner's representative shall be invited to witness field testing. The representative shall be notified of the start date of the testing phase five business days before testing commences.

B. Category 6A – Performance Test Parameters: The test parameters for Cat 6A are defined in the TIA Cat 6A standard. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test, all measurements (at each frequency in the range from 1 MHz through 500 MHz) must meet or exceed the limit value determined in the above-mentioned standard.

1. Wire Map: Shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.

2. Length: The field tester shall be capable of measuring length of all pairs of a basic link or channel based on the propagation delay measurement and the average value for NVP (1). The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP.

3. Insertion Loss (Attenuation): Insertion Loss is a measure of signal loss in the permanent link or channel. The term "Attenuation" has been used to designate "Insertion Loss." Insertion Loss shall be tested from 1 MHz through 500 MHz in maximum step size of 1 MHz. It is preferred to measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter. Minimum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.

4. NEXT Loss: Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through 500 MHz. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin and the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

Table 1 -- Maximum frequency step size as defined in

Frequency Range (MHz)	**Maximum Step size (MHz)**
1 – 31.25	0.15

31.26 – 100	0.25
100 – 250	0.50
250 – 500	1.00

5. PSNEXT Loss: Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PSNEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 through 500 MHz and the step size may not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PSNEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

6. ELFEXT Loss, pair-to-pair: Pair-to-pair FEXT Loss shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ELFEXT Loss that must be evaluated and reported in the test results. ELFEXT measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ELFEXT is to be measured from 1 through 500 MHz and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the standard as in Table 1. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

7. PSELFEXT Loss: Power Sum ELFEXT is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through 500 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

8. Return Loss: Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through 500 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the

frequency at which it occurs as well as the test limit value at this frequency.

9. Propagation Delay: Propagation delay is the time required for the signal to travel from one of the link to the other. This measurement is to be performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

10. Delay Skew [as defined in the TIA Cat 6A Standard; Section 7.5] This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

11. PS ANEXT: Pair-to-pair Alien NEXT (ANEXT) contributions is measured by applying the stimulus signal at the near end to one wire pair of a disturbing link and measuring the coupled signal at the near end of a wire pair in a disturbed link. This process is repeated for every wire pair in a disturbing link. The PS ANEXT for each wire pair in a disturbed link is obtained by the power sum addition of all the pair-to-pair ANEXT results to that wire pair from all wire pairs in disturbing links. All the links that are bundles with the disturbed link need to be included as disturbing links. In addition, links that are terminated in adjacent positions in a patch panel or interconnect panel must also be included as disturbing links in this test.

12. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS ANEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

13. PS AACR-F: The pair-to-pair Alien Far End crosstalk (AFEXT) contributions is measured by applying the signal at the near end to one wire pair of a disturbing channel or permanent link and measuring the coupled signal at the far end of a wire pair in a disturbed channel or permanent link. This process is repeated for every wire pair in a disturbing link and for all links in close proximity. A normalization, which is dependent on the relative length of disturbing and disturbed link, is applied to each pair-to-pair alien FEXT measurement. Then the PS Alien Attenuation-to-Crosstalk Ratio from the Far end (PS AACR-F) for each wire pair in a disturbed channel or permanent link is obtained by the power sum addition of all the normalized pair-to-pair far end alien crosstalk results to that wire pair from all wire pairs in disturbing links in close proximity.

14. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS AACR-F. if the link or channel connects two patch panels (data center), these wire pairs must be identified for the tests performed from both ends. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

C. Category 6/6A Test Result Documentation

1. The test results/measurements shall be transferred into a Windows™-based

database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.

2. The database for the completed job shall be stored and delivered on CD-ROM including the software tools required to view, inspect, and print any selection of test reports.

3. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information

    a. The identification of the link in accordance with the naming convention defined in the overall system documentation

    b. The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number

    c. The date and time the test results were saved in the memory of the tester.

4. General Information to be provided in the electronic data base with the test results information for each link:

    a. The identification of the customer site as specified by the end-user

    b. The identification of the link in accordance with the naming convention defined in the overall system documentation

    c. The overall Pass/Fail evaluation of the link-under-test

    d. The name of the standard selected to execute the stored test results

    e. The cable type and the value of NVP used for length calculations

    f. The date and time the test results were saved in the memory of the tester

    g. The brand name, model and serial number of the tester

    h. The identification of the tester interface

    i. The revision of the tester software and the revision of the test standards database in the tester

    j. The test results information must contain information on each of the required test parameters that are listed in Section B and as further detailed below under paragraph C6.

5. In-link (In-Channel) detailed test results. The detailed test results data to be provided in the electronic database for must contain the following information:

    a. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a

summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.

b. Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m and the test limit value

c. Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value

d. Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value

e. Insertion Loss (Attenuation): Minimum test results documentation as explained in Section B for the worst pair

f. Return Loss: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link

g. NEXT, ELFEXT: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link

h. PSNEXT and PSELFEXT: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link

6. Between-Link (Between-Channel) Test Results Data. A test report shall be provided for each disturbed link included in the Alien Crosstalk sample test. This test report must contain

7. PS ANEXT results at each frequency (See Table 1) for each wire pair in a victim link as well as the PS ANEXT results for the average of these four wire pairs. The worst case margin and the worst values shall be provided for each wire pair and the average of the four wire pairs. PSANEXT shall be measured and tested from the end of the link or channel where all cables are terminated at a distribution panel. In case the cabling runs from panel to panel (data center), the PS ANEXT test results for each disturbed link shall be collected and saved from both ends (both panels) of the disturbed link.

8. PS AACR-F results at each frequency tested (See Table 1) for each wire pair in a disturbed link as well as the PS AACR-F results for the average of the four wire pairs. The worst case margin and the worst values shall be provided for each wire pair and the average of the four wire pairs. PS AACRF only needs to be measured and tested from one end of the link or channel. Connect the main DTX-1800 unit (measurement of PS AACR-F disturbance) to the disturbed link or channel at the end where all cabling links are terminated at a distribution panel. Select End 1 in the AxTalk Analyzer Software.

D. Optical Fiber Cable Testing: All fiber testing shall be performed on all fibers in the completed end to end system. There shall be no splices unless clearly defined in Section 3 of this specification. Testing shall consist of a bi-directional end to end OTDR trace performed per ANSI/TIA/EIA 455-61 & ANSI/TIA/EIA 526 and a bi-directional end to end power meter test performed per ANSI/TIA/EIA 455-53A. The system loss measurements shall be provided at 850 and 1300 nanometers for multimode fibers and

1310 and 1550 for single mode fibers.

1. Pre-installation cable testing: The Contractor shall test all lightguide cable prior to the installation of the cable. The Contractor shall assume all liability for the replacement of the cable should it be found defective during the warranty period.

2. Loss Budget: Fiber links shall have a maximum loss of: (allowable cable loss per km)(km of fiber in link) + (.4dB)(number of connectors) = maximum allowable loss.

3. Any link not meeting the requirements of the standard shall be brought into compliance by the contractor, at no charge to Owner.

E. HD-SDI coax cable testing

1. 12G HD-SDI – Adhear to SMPTE OV2082-0.2018 Standards.

2. 11.88 Ghz Support.

F. The Contractor shall provide test documentation to the Owner's Project manager in a three ring binder(s) and CD format within three weeks after the completion of a specific project. The binder(s) shall be clearly marked on the outside front cover and spine with the words "Test Results", the project name, and the date of completion (month and year). The binder shall be divided by test type. Test data within each section shall be presented in the sequence listed in the administration records. The test equipment by name, manufacturer, model number, and last calibration date shall also be provided at the end of the document. Unless a more frequent calibration cycle is specified by the manufacturer, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test.

G. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be collocated in the binder.

3.9 FINAL INSPECTION AND ACCEPTANCE (SEE SECTION 3.02 FOR ADDITIONAL REQUIREMENTS)

A. After all requirements of the Specifications and/or the Drawings have been fully completed, representatives of the Owner will inspect the work. Contractor shall provide competent personnel to demonstrate the operation of any item or system to the full satisfaction of each representative.

B. Final acceptance of the work will be made by the Owner after receipt of approval and recommendation of acceptance from each representative.

C. Upon testing by the Owner's Representative (Consultant) any deficiencies shall be noted. If the deficiencies are not correctable at the time of testing, any retesting costs by the Consultant, including any travel and lodging expenses shall be borne solely by the Contractor.

3.10 ACCEPTANCE TESTS – PUNCH LIST JOB WALKS

A. Qualification for Acceptance: After completing preliminary testing, the Contractor shall

furnish the Construction Manager with the letter/report documenting the results of the preliminary tests and two (2) copies of "as-built" wiring diagrams of the entire system including the connection numbers, and their locations. The receipt of this documentation shall constitute the Contractor's acknowledgment that the installation is complete and conforms to this specification and is ready to be reviewed and tested by the AV Design Consultant.

B. Acceptance Test: The Consultant, Owner's Representative and/or Construction Manager will be present during the acceptance testing and require the assistance and cooperation of the AV Installation Contractor. Provide personnel who participated in the actual installation and preliminary testing and adjustment of the audiovisual systems.

C. Equipment cabinet keys and any tamper-proof fastener tools must be available to the AV Design Consultant. Delays associated with failure to access the equipment shall be back charged to the Contractor at the AV Design Consultant's current hourly rates.

D. Each major component shall be demonstrated to function, as specified.

E. The AV Contractor shall provide a laptop computer with all manufacturers supplied configuration software necessary for communicating with Control Systems, DSP Audio Matrix Mixers, and the Audiovisual System Switchers. A review of system settings may be required for either of the programmable units at the AV Design Consultant’s request, and settings may be adjusted if necessary.

F. Such tests may be performed on any piece of equipment or system. If any test shows the equipment or system is defective or does not comply with the specifications, the Contractor shall perform any remedies at his expense and pay the subsequent expenses of any retesting required.

G. Delays: If system acceptance is delayed because the system is found to not meet the specification requirements, the Contractor shall reimburse the Owner for all consultant expenses related to re-testing. This shall include costs associated with travel to the site and any associated business travel expenses.

3.11 SYSTEM DOCUMENTATION, TRAINING, AND FIELD SUPPORT

A. Operation and Maintenance Manuals: For each system, provide three (3) copies of system manuals per system, two (2) for the Owner and one (1) for the AV Design Consultant. Manuals shall be in adequately sized three-ring binders, clearly labeled on spine. Manuals shall contain the following:

B. Service Reference Cover Sheet: Provide a cover sheet with Contractor name, address, Email, WEB Address, Phone.

C. System Operation Instructions: Step-by-step operating instructions for the basic day-to-day use of the system including power activation, connection of source devices, adjustment of volume levels, selection of sources, etc. Include illustrations and references to individual equipment manuals, as necessary.

D. Equipment Manuals: Include copies of individual equipment operation manuals separated by tabbed dividers. Arrange the manuals in nominal signal path order (i.e., sources first, amplifiers/loudspeakers last), followed by control system manuals, followed by miscellaneous manuals.

E. Equipment List: List all system equipment including connectors and specialty hardware, by manufacturer and model and serial number.

1. As-built Drawings: Provide one set, reduced 11”x17” foldout "as built" functional diagrams in transparent plastic binder sleeves. Fold and insert drawings so that drawing title is clearly visible at the front of the sleeve. In addition, provide two full-size drawing sets.

2. Provide current software programmable device configuration files to the Owner for all control system interfaces and computer-based files, and the DSP Audio Matrix Mixer. Store files on site in the system documentation binders in disk sleeves. Provide the files on USB.

3. Complete spreadsheet lists of IP network devices, protocols used, and IP and MAC Address lists and required ranges for coordination with the Owner's IT department.

4. Provide all network switch configuration files. Identify which configuration file is loaded into each switch.

5. Provide Ip Network diagram with all interconnections and VLANS programmed into the network.

F. Lists shall include information regarding location on the Owner's network or dedicated audiovisual physical subnet, VPN requirements, and other pertinent information for integration of IP networked audiovisual equipment into the Owner's Enterprise network.

G. Training: Provide hours as needed of system training to operator(s) designated by the Owner. Training time is to be non-contiguous, in multiple separate sessions. Training sessions are to be digitally recorded upon Owner request.

H. All training shall take place after the systems are operational, but before the acceptance tests.

I. Operational Training:

1. In the event the Installing Contractor does not have qualified instructors on staff for certain sophisticated equipment, the Installing Contractor, at no additional cost to Owner, shall provide a manufacturer’s representative for such instruction to the Owner.

J. Training Materials Supplied:

1. System operational manual (not equipment operation manuals) that explains how to fully operate the system; from start-up to shut down, and all operational steps in-between, in a step-by-step description, with pictures and other visuals to help convey information.

2. The Installing Contractor shall video record training session(s) for Owner’s reference (to help limit minor follow up phone calls in the future).

K. Maintenance Training:

1. A session with Owner’s designated technical personnel for routine and

preventive maintenance shall be given.

a. This training is for scheduled preventative maintenance for such items as filter and lens cleaning, minor equipment checks and “user” adjustments.

1) This training is not meant to teach Owner’s representatives how to use commercial test equipment and/or do sophisticated equipment/system alignment.

L. Training Materials Supplied:

1. Utilizing the equipment manuals and flow diagrams of the required in contract closeout submittals supply a listing with suggested preventative maintenance schedule of the system equipment.

M. Training Format

N. Presenter: The presenter of the training sessions to have been directly involved with the project and have intimate knowledge of the installed systems and its operation. The presenter to be experience operating similar systems of similar complexity.

O. Attendees: The End User to determine who shall attend Audio & Video Training. Group to be limited to 10 persons. Training to occur at building site and be coordinate with Owner’s Schedule and Calendar.

P. Classroom presentation: PowerPoint Presentation covering items indicated in syllabus. Duration of classroom training does not exceed 4 hours.

Q. Field Instruction: Hands On presentation covering items indicated in syllabus. Minimum duration of field instruction:

1. Video System Operation – 6 hours

2. Audio System Operation – 6 hours

3. One month follow up – 4 hours.

R. Audio Systems Training Syllabus

S. Section 1 - Introduction to Audio Systems

1. Decibels – Explain the concept of Decibels and its application in dBu and dBSPL. Provide references for each.

2. Frequency – Explain the concept of Frequencies and a relationship to octaves and musical notes.

3. Voltage – Provide description of microphone, line and speaker levels.

4. Gain Structure – Provide description and example of proper gain structure along with an explanation of clipping and headroom.

T. Section 2 – Introduction to Project Systems (Provide the following for each system in project)

1. Inputs – Present floor plans indicating location of technical panels with brief description of input connectors.

2. Controls – Present floor plans indicating location of wall controls and mix locations.

3. Review the setup and adjustment of the output devices.

4. Review the maintenance of the video equipment.

U. Section 3 – Microphone Selection and Application

1. Provide explanation of proper microphone selection to include:

a. Type of microphone: Boundary, Condenser, Dynamic, etc.

b. Type of coverage: Omni, Cardioid, Semi Cardioid, etc.

V. Provide explanation of proper microphone application to include:

1. General Handling and placement for handheld applications

2. General Handling and placement for stand applications

3. 3 to 1 rule with respect to interference

4. 3 dB rule with respect to headroom

W. Section 4 – Field Instruction

1. Mixing Console Operation

2. Explanation of signal path

3. Review of Aux sends.

4. Review of Groups

5. Explanation of Mute Groups

6. Explanation of Matrix

7. Review of Main Section

8. Review of Metering

9. Tie Line Description

X. Video System Training Syllabus

Y. Section 1 – Introduction to Video Systems

1. Provide description of digital and analog video signal types.

2. Discuss the properties of a quality video image.

Z. Section 2 – Introduction to project systems

1. Inputs – Present floor plans indicating location of technical panels with description of input connectors.

2. Controls – Present floor plans indicating location of wall controls and mix locations.

3. Components – Present Schematic diagram (based on shop drawings) indicating description of signal flow and components of the system.

AA. Section 3 – Field Instruction

1. Demonstrate the process of inputting media.

2. Review the process or routing the signals through distribution.

3. Review the setup and adjustment of the output devices.

4. Review the maintenance of the video equipment.

BB. Support Materials

1. Training Manuals - Provide three ring binders for each attendee with the following:

a. Cover sheet indicating Audio Training.

b. Contact information for Audio Contractor and Audio Consultant

c. Table of Contents

d. Printed copy of PowerPoint presentation.

e. Copy of Materials List

f. Copy of Loose Equipment Materials List and Product Cut Sheets

g. Owners and Instruction Manuals. Make Owners and Instruction manuals available and complete for reference during training.

h. Record Documents Make Record Document available and complete for reference during training.

i. Submit training support material binder to AV Consultant for approval prior to training sessions.

CC. Follow-up training within sixty (60) days shall also be provided.

DD. Single Point of Contact: Contractor shall provide an English proficient, single point of contact, i.e., Project Manager, to speak for the Contractor and to provide the following functions:

EE. Initiate and coordinate tasks with Owner's Project Manager, and others as specified by Owner's Project Manager.

FF. Provide day-to-day direction and on-site supervision of Contractor personnel.

GG. Ensure conformance with all Contract provisions.

HH. Participate in weekly site project meetings as needed.

II. This individual shall remain as Project Manager for the duration of the project. The Contractor may change Project Managers only with the Owner's Project Manager's written approval.

JJ. Planning meetings and schedule: Within thirty (30) calendar days after the date of award of the Contract, an initial planning meeting shall be held with the successful bidder to clarify all requirements (systems, services, distribution methods, etc.), identify responsibilities, and schedule the events that shall transpire during the implementation of the project. Within one (1) week of this initial meeting, the Contractor shall provide a written report and project schedule to clearly document the events and responsibilities associated with the project.

KK. Site Cleaning: Throughout the progress of the plant construction, the Contractor shall keep the working area free from debris of all types and remove from the premises all rubbish resulting from any work done by Contractor. Daily and at the completion of its work, the Contractor shall, to the extent possible, leave the premises in a clean and finished condition.

LL. Safety Requirements: Contractor shall utilize appropriate personnel and display warning signs, signals, flags, and/or barricades at the work site to ensure adherence to safety regulations and as prudence requires.

MM. Specification/Drawing Status: All specifications and drawings related to this project shall be "frozen" after shop drawing approval. The Owner reserves the right to negotiate any future changes with the Contractor at any time.

NN. Upon approval of shop drawings, Contractor shall immediately place orders for all required materials, components, and supplies. In addition, Contractor shall secure and forward written confirmations (including orders and shipping dates) direct from each manufacturer/vendor to the Owner's Project Manager.

OO. Contractor shall expedite shipment of all materials, components, and supplies, as necessary to ensure the successful completion of the Project by the date required. All costs for expediting shall be included within Contractor's pricing as provided below.

PP. The system cost herein shall include administration/maintenance training for at least ten Owner's representatives with a minimum allotment of sixteen (16) hours. Additional hours of training shall be as required at no additional expense to the owner. All training shall include written and/or video materials that shall remain the property of Owner. If materials are written, they shall be provided in quantities sufficient for each person trained; if materials are video, one copy of each shall be required. The administration/maintenance training shall include, but not be limited to, the following:

QQ. Review of as-built documentation, including a site demonstration.

RR. All warranty information.

3.12 DAMAGES

A. The Contractor shall be held responsible for all damages to portions of the building caused by it, its employees, or sub-contractors; including but not limited to:

B. Damage to any portion of the building caused by the movement of tools, materials, or equipment.

C. Damage to any component of the construction of spaces.

D. Damage to the electrical, mechanical and/or life safety or other systems caused by inappropriate operation or connections made by the Contractor or other actions of Contractor.

E. Damage to the materials, tools and / or equipment of the Owner, its consultants, agents, and tenants.

3.13 INSPECTIONS

A. On-going inspections shall be performed during construction by the Owner's Project Manager. All work shall be performed in a high-quality manner and the overall appearance shall be clean, neat and orderly. The following points will be examined and must be satisfactorily complied with:

B. Are all cables properly labeled, from end-to-end?

C. Have all terminated cables been properly tested in accordance with the specifications for the specific category as well as tested for opens, shorts, polarity reversals, transposition and presence of AC and/or DC voltage?

D. Have the pathway guidelines been followed? Are all cable penetrations installed properly, and fire stopped according to code?

E. Has the Contractor avoided excessive cable bending?

F. Is Cable fill, correct?

G. Are terminations compatible with applications equipment?

H. Are connectors properly turned right side up in the Jack Panels or faceplates without cables wrapped or twisted?

I. Is the jacket maintained right up to the termination?

J. Are identification markings uniform, permanent and readable?

3.14 COMPLETION OF WORK

A. At the completion of the System, the Contractor shall restore to its former condition, all aspects of the project site and daily, shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract. All clean up, restoration, and removal noted above shall be by the Contractor and at no cost to Owner. If the Contractor fails in its duties under this paragraph, Owner may upon notice to the Contractor perform the necessary clean up

and deduct the costs thereof from any amounts due or to become due to the Contractor. It shall be the Contractor's responsibility to remove trash from the areas it is working in and bring trash and debris to the Contractor provided dumpster.

B. Final Punch Walk: The Contractor and owner shall complete a final inspection to determinate if all conditions of the scope of work are completed to the owner's satisfaction. A "punch list" shall be formulated within (2) days of the punch walk and be presented to the Contractor for completion prior to final project sign-off by the owner. If an item is missed during the punch walk or not included on the "punch list" for any reason, it does not release the Contractor from completing the scope of work as defined in the specification or drawings.

C. Contractor shall submit complete Record Documentation as outlined in submittals section prior to project sign-off by owner.

3.15 SYSTEM AND/OR NETWORK TESTING

A. Upon completion of installation, Contractor shall execute all the required tests as summarized in this specification. When all such tests have been completed to Owner's satisfaction and Manufacturer's specifications, Contractor shall give the Owner written notice thereof.

B. Contractor must assume responsibility for assuring that the system and network interface installed operates properly, including any required coordination with other suppliers.

3.16 FINAL ACCEPTANCE

A. The Owner or Owner's representative may visit the site during the installation of the system to ensure that correct installation practices are being followed.

B. The Owner or Owner's representative will conduct a final job review once the Contractor has finished the job. This review will take place within one week after the Contractor notifies the owner.

C. Two copies of all certification data and drawings for all identifications shall be provided to the Owner before the owner's review.

D. The Owner or Owner's representative will review the installation and certification data prior to the system acceptance.

E. The Owner or Owner's representative may test some of the systems features to ensure that the certification data is correct. If a substantial discrepancy is found, the Owner reserves the right to have an independent consultant perform a certification of the entire system. If such a procedure is undertaken, the cost of the testing shall be billed back to the Contractor.

F. If repairs or adjustments are necessary, the Contractor shall make these repairs at his own expense. All repairs shall be completed within 5 days from the time they are discovered.

G. The Contractor shall hand to the owner a copy of any applicable installation specific software configurations in USB format.

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SECTION 27 51 00 - ASSISTIVE LISTENING SYSTEMS (ALS)

PART 1 - GENERAL

1.1 SUMMARY

A. The work includes the provision of Assistive Listening Systems (ALS) as part of the building project.

B. The system(s) shall be in accordance with 2019 CBC Title 24 Part 2 Volume 1&2, Section 11B-219 and comply with Section 11B-706.

C. Provide correct number of portable receivers and accessories to accommodate four (4) percent of listed occupancy rating per location as required per code and the plan drawings. Refer to CBC Section 11B-219.3 Exception #1 when calculating total number of receivers where a building contains more than one (1) assembly area.

D. Twenty-five (25) percent of the portable receivers shall come equipped with hearing-aid compatible neck induction loops. Seventy-five (75) percent of the portable receivers shall come equipped with ear speakers.

E. The permanent Assistive Listening System(s) shall be provided by the Contractor and shall function with the voice reinforcement systems to be installed by the Audiovisual Contractor or Owner.

F. The portable Assistive Listening System(s) shall be provided by the Contractor.

G. Scope of Work: The work shall consist of the design, provision, termination, testing, and documentation of complete and fully functional permanent and portable Assistive Listening System(s). The instructions in this section are specific to the ALS installations and should be read in conjunction with other contract documents as applicable.

H. Deliverables: Prior to ordering materials or commencing any construction activities, the contractor shall provide the Owner with a complete bill of materials, including all quantities of components, devices, equipment, and wiring required to complete this work.

I. Prior to ordering equipment, Contractor shall perform a radio frequency (RF) test to determine and identify any potential RF interference. Contractor shall be responsible to select ALS system radio frequencies that do not receive RF interference from other in-building systems such as lighting, power, generators, HVAC, computers, audio, paging, etcetera. Refer to Part 3 for additional requirements.

PART 2 - PRODUCTS

2.1 MATERIALS. The following is to be used as a GUIDE, and are to be included, but not limited to, in the system(s) to be supplied. Provide current products.

A. Listen Technologies LT-700(xx) Portable FM Transmitter

1. The portable FM transmitter shall be capable of broadcasting on 57 channels. The unit shall incorporate a microphone sensitivity switch. The device shall broadcast on both wide and narrow band channels with a SNR of 80dB or greater. The device shall have an audio frequency response of 50Hz to 15 kHz (±3 dB). at 72MHz, or of 50Hz to 10 kHz, (±3 dB). at 216MHz. The device will incorporate a mute switch and the battery door shall be capable of being mechanically locked. The device shall incorporate an LCD display that indicates channel, battery level, low battery, battery charging, and RF signal strength. The portable transmitter shall incorporate automatic battery charging circuitry for the recharging of NiMH batteries, with the ability to charge via a wall transformer or drop in charging case. Each portable transmitter shall come equipped with its own patch cable allowing them to easily interface with the input of a stationary sound system anywhere on campus. Include one (1) line input cable with each portable transmitter. Listen Technologies part numbers LT-700-072, LT-700-216.
2. Provide two (as required) portable transmitters.

B. Listen Technologies LR-4200(xx) Portable Receiver

1. The FM receiver shall be capable of receiving on 57 wide and narrow band channels. The receiver shall tune to a single channel and user shall not be able to change the channel. The receiver shall have a signal-to-noise (SNR) ratio of 80 dB or greater (70dB for the 216MHz models) and shall have an audio frequency response of 50 Hz - 15 kHz (±3 dB). The receiver shall employ a unique DSP SQTM noise reduction technology. The receiver shall have a programmable squelch circuit. The receiver shall incorporate a multi-functional display (OLED) that indicates battery status, inventory number, volume level and customizable channel names. The receiver shall have the option of being lanyard or belt clip worn and the lanyard shall incorporate an integrated neck loop for compatibility with T-coil hearing aids. The receiver shall be intelligent and provide customized audio to either earphones or the integrated neck loop based upon which is connected. The receiver shall have two (2) 3.5 mm (TRRS) connectors to drive the integrated neck loop lanyard or up to two (2) mono or stereo earphones. The receiver shall be fully programmable via supplied software. The receiver shall have a micro-USB connector used for programming/setup, inventory control, charging, and firmware upgrades. The receiver shall incorporate automatic battery charging circuitry and use a non-proprietary lithium ion (Li-ion) battery. The receiver shall automatically turn on when removed from the charging device and automatically turn off when returned to the charging device. The receiver shall have additional charging contacts to allow multiply charging options. The receiver shall be covered by a hassle-free limited lifetime warranty. Listen Technology part numbers LR-4200-072, LR-4200-216.
2. PROVIDE QUANTITY REQUIRED PER 2016 CBC 11B ALS REQUIREMENTS. Refer to ALS System Notes/Matrix on the plan drawings.

C. Listen Technologies LT-84-01 Transmitter/Radiator

1. The Infrared Transmitter/Radiator Combo shall be capable of broadcasting up to two (2) audio channels with the choice of four (4) mono carrier frequencies; 2.3, 2.8, 3.3 and 3.8 MHz Channel carrier selections shall be set via a back panel rotary switch. The Transmitter/Radiator coverage area shall be up to 30,000 ft² (2787 m²) with LR-4200-IR/LR-5200-IR receivers or 7,500 ft² (697 m²) with LR-42/LR-44 receivers in single channel mode. The device shall have a timer that shuts off the carriers after 15 minutes when no audio is present at the inputs. The Transmitter/Radiator shall have a SNR of 60 dB or better and THD of less than 2%. The device shall have an audio frequency response of 63 Hz to 15 kHz, +/- 3db. The device shall have two (2) independent mixing audio inputs, one for each transmission channel. Each mixing input shall consist of one (1) 3.5 mm Microphone input, one (1) balanced Phoenix type input and one (1) unbalanced RCA stereo summing input. The device shall have independent channel audio processing with Limiting, Compression and Noise Gate as well as transmit level control and level indication via two (2) LEDs. The Transmitter/Radiator shall provide Power and RF signal for up to Four (4) Expansion Radiators over a single CAT-5e cable. The LT-84 is specified.

D. Listen Technologies LR-4200-IR Receiver

1. The IR receiver shall be capable of receiving on four (4) wide band channels (carriers), Channel 1 (2.3 MHz), Channel 2 (2.8 MHz), Channel 3 (3.3 MHz) and Channel 4 (3.8 MHz). The receiver shall be tuned to a single channel and users shall not be able to change the channel. The receiver shall have the option of being lanyard or belt clip worn and the lanyard shall incorporate an integrated neck loop for compatibility with T-coil hearing aids. The receiver shall be intelligent and provide customized audio to either earphones or the integrated neck loop based upon which is connected. The receiver shall have two (2) 3.5 mm (TRRS) connectors to drive the integrated neck loop lanyard or up to two (2) mono or stereo earphones. The receiver shall incorporate a multi-functional display (OLED) that indicates battery status, inventory number, volume level and a customizable channel name. The receiver shall employ a unique iDSPTM noise reduction technology. The receiver shall be fully programmable via PC software. The receiver shall have a micro-USB connector used for programming/setup, inventory control, charging and firmware upgrades. The receiver shall incorporate automatic battery charging circuitry and use a non-proprietary lithium-ion battery. The receiver shall automatically turn on when removed from the charging device and automatically turn off when returned to the charging device. The receiver shall have additional charging contacts to allow for multiple charging options. The receiver shall have a signal-to-noise ratio of 60 dB or greater, THD less than 2% and shall have an audio frequency response of 63 Hz – 15 kHz (±3 dB). The Listen LR-4200-IR is specified.

E. Listen Technologies LT-82 IR Transmitter.

1. The Stationary IR Transmitter shall be capable of broadcasting on four (4) mono or stereo carriers; 2.3, 2.8, 3.3 and 3.8 MHz Channel Selection shall be capable of being locked. Multiple transmitters shall be capable of being daisy-chained together to transmit up to four (4) channels simultaneously. The transmitter shall have a timer that shuts off the carriers after 30 minutes when no audio is present at the transmitter. The transmitter shall have a SNR of 60 dB or better. The device

shall have an audio frequency response of 63 Hz to 15 kHz, +/- 3db. It shall have two (2) mixing audio inputs, one (1) balanced XLR/phone input and one (1) unbalanced RCA input. The device shall have the following audio controls: input level, transmit level, contour level and stereo on/off control. The device shall have an audio processor that is capable of automatic gain control and limiting. The transmitter shall provide power for up to two (2) radiators over CAT-5 cable. The LT-82 is specified.

F. Listen Technologies LT-800-(xx) RF Transmitter.

1. Furnish and install an RF wireless assistive listening system for use by the hearing-impaired. The assistive listening system (ALS) shall be capable of broadcasting on 57 channels and be frequency agile. The RF receiver shall be capable of receiving on 57 wide and narrow band channels. The device shall tune to a single channel and user shall not be able to change the channel. The receiver shall have a signal-to-noise ratio of 70 dB or greater and shall have an audio frequency response of 50 Hz – 15 kHz (±3 dB). The device shall employ a unique DSP SQTM noise reduction technology. The unit shall have a programmable squelch circuit. The unit shall incorporate a multi-functional display that indicates battery status, inventory number and channel. The device shall have the option of being lanyard or belt clip worn and the lanyard shall have the option of an integrated DSP driven neck loop that automatically senses and sends optimized audio signals directly to hearing aids and cochlear implants equipped with telecoils. The neck loop shall have a field strength of 400 mA/m (+/- 3dB) and frequency response of 100Hz to 5kHz (+/- 3 dB ref 1kHz). The device shall have a USB connector used for inventory control, set up, charging and firmware upgrades. The device shall incorporate automatic battery charging circuitry and use a non-proprietary lithium-ion battery. The device shall have additional charging contacts to allow multiple charging options. The ALS system shall have 70dB SNR or greater, end-to-end. Listen Technologies Corporation products are specified.

G. Listen Technologies LR-4200-(xx) RF Receiver.

1. The RF receiver shall be capable of receiving on 57 wide and narrow band channels. The device shall tune to a single channel and user shall not be able to change the channel. The receiver shall have a signal-to-noise ratio of 70 dB or greater and shall have an audio frequency response of 50 Hz – 15 kHz (±3 dB). The device shall employ a unique DSP SQTM noise reduction technology. The unit shall have a programmable squelch circuit. The unit shall incorporate a multi-functional display that indicates battery status, inventory number and channel. The device shall have the option of being lanyard or belt clip worn and the lanyard shall have the option of an integrated neck loop. The device shall have a USB connector used for inventory control, set up, charging and firmware upgrades. The device shall incorporate automatic battery charging circuitry and use a non-proprietary lithium-ion battery. The device shall have additional charging contacts to allow multiple charging options. The Listen LR-4200-216 is specified.

2.1 ACCESSORIES

A. Listen Technologies #LA-261 lavalier microphone. Provide one (1) for each portable transmitter.

B. Listen Technologies #LA-130 antenna. Provide one (1) for each permanent ALS transmitter.

C. Listen Technologies #LA-164 ear speakers. Provide over-the-ear design, single ear clip, for use with portable receivers. Seventy-five (75) percent of total quantity of receivers shall be equipped with ear speakers.

D. Listen Technologies #LA-166 neck loops. Provide neck loops for wireless connection to hearing aids equipped with a “T” coil. Twenty-five (25) percent of total quantity of receivers shall be equipped with neck loops.

E. Listen Technologies #LA-263 line-input cable. Provide one (1) for each portable transmitter, and for each permanent transmitter.

F. Listen Technologies charging-carrying case. Provide combination charging/carrying case(s) with drop-in charging stations for simultaneous charging of up to 16 portable transmitters/receivers, auto shut-off feature to prevent over-charging, and shall be hard-sided and lockable. Provide quantity as required to charge all portable transmitters and receivers at the same time. LA-317-01 (4-unit combination charging-carrying case).

G. Listen Technologies #LA-362 NiMH rechargeable AA batteries. Provide two (2) NiMH rechargeable AA batteries for each portable transmitter and receiver.

H. Listen Technologies #LA-304 ALS system notification signage. Provide Listen Technologies signage kits, or as directed by the Architect. Refer to architectural drawings for required quantities, type, and locations.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Prior to ordering equipment, Contractor shall perform a radio frequency (RF) test to determine and identify any potential RF interference. Contractor shall be responsible to select ALS system radio frequencies that do not receive RF interference from other in-building systems such as lighting, power, generators, HVAC, computers, audio, paging, etcetera. Final system testing shall be conducted with all building systems turned on (lighting, power, generators, HVAC, etc.) to

verify the ALS system is free from local RF interference.

B. Cables within racks and cabinets shall be carefully wrapped and secured with Velcro-type strip fasteners. Nylon-type “zip ties” or tie-wraps are prohibited. All cables shall be numbered for identification within 6 inches from both ends. Contractor shall provide cable numbering on final as-built drawings.

C. The Contractor shall, upon completion of the system, orient all antennas, adjust all controls, etcetera, to provide a system operating at maximum capability.

D. The system must meet all local and other prevailing codes.

E. Equipment to be installed in accordance with manufacturer’s instructions.

3.2 TESTING

A. Following the installation of transmitters. each transmitter and receiver will be tested.

B. Demonstrate complete radio reception coverage of the entire seating area(s) has been provided by the Contractor.

C. Receivers shall be tested to verify proper function as specified by manufacturer.

D. All transmitters and receivers will be tested simultaneously to ensure no channel conflicts occur.

E. Demonstrate all portable transmitters and receivers can properly charge at the same time while in the charging carrying cases.

F. Demonstrate proper use and functions of the entire system and components.

G. These testing requirements are to be successfully completed before hand-off to College or to the College’s representative for remaining Audiovisual System integration to test for short-life product failures.

3.3 WARRANTY

A. Provide manufacturer’s standard warranty.

B. Contractor to provide all completed product warranty cards or register product with product manufacturer for the College.

END OF SECTION 275100

SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Protecting existing trees, shrubs, groundcover, plants and grass to remain.
2. Removing existing trees, shrubs, groundcover, plants, grass, A.C. paving and base material and existing concrete slabs.
3. Clearing and grubbing, removal of existing brush and trees, unless shown to remain.
4. Stripping and stockpiling topsoil.
5. Removing above and below grade site improvements.
6. Disconnecting, capping or sealing and removing site utilities.
7. Temporary erosion and sedimentation control measures.

B. The contractor attention is directed to the requirements in Division 1 regarding the preservation of existing trees. The work also includes the removal and disposal of obstacles above and below ground that conflict with the work in this project whether or not such obstructions are as shown on the plans.

C. Related Sections include the following:

1. Division 1 for temporary utilities, temporary construction and support facilities, temporary security and protection facilities and temporary erosion and sedimentation control procedures.
2. Division 1 Section "Field Engineering" for verifying utility locations and for recording field measurements.
3. Division 2 Section "Tree Protection and Trimming" for protecting trees remaining on-site that are affected by site operations.
4. Division 2 Section "Earthwork" for soil materials, excavating, backfilling and site grading.
5. Division 2 Section "Lawns and Grasses" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.2 REFERENCED STANDARDS:

A. The editions, specifications and standards referenced herein, published by the following organizations apply to the construction only to the extent specified by the reference.

B. Standard Specifications:

1. Standard Specifications for Public Works Construction (current edition).

2. Standard Special Provisions of the Regional Standards Committee.
3. California Department of Transportation, "Manual of Traffic Controls, for Construction and maintenance Work Zones", (current edition), Document No. 869159.

C. Standard Drawings:

1. City of Fontana Standard Plans, (current edition).

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain City's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, according to Division 1 Section "Project Closeout," identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Quality Control."

1.7 PROJECT CONDITIONS

A. The plans show general information only. It shall be the responsibility of the Contractor to examine the site to determine the exact existing conditions and character and extent of the work to be performed and clearing operations required.

B. Existing underground lines shown on the plans are shown from best possible information available and shall be verified prior to start of any work. The Contractor is responsible for locating all underground lines by potholing and/or locator service.

C. Preserve in operating condition all active utilities transversing or within and about the site. Promptly repair any damage to such utility or work due to work under this contract, to the satisfaction of the City Inspector.

D. Existing appurtenances and improvements, which are to remain, shall be protected from damage due to work under this section. Such damaged facilities shall be promptly repaired and/or replaced in kind.

E. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from City and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

F. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining City's property will be obtained by the City before award of Contract.

1. Do not proceed with work on adjoining property until directed by City's Representative.

G. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on at a location that is agreeable with the City Representative.

H. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

1.8 BARRICADES AND WORK AREA:

A. Provide barricades and warnings (signs and lighting), and maintenance and supervision thereof, in accordance with applicable Federal and State codes and their respective requirements, or as may be directed from time to time by the City's Representative. Do not commence site clearing until barricades and warnings are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 2 Section "Earthwork."

1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 GENERAL:

A. Clear and grub per Section 0300-1 standard specifications except as modified herein.

3.2 LIMITS:

A. The limits of clearing, grubbing and demolition shall include all areas of work.

3.3 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction. The contractor shall prepare a pre-construction Corner Record and file it with the County Surveyor prior to starting construction for any survey monuments to be destroyed during the course of construction. Upon completion of construction survey monuments destroyed during construction shall be reset and a post-construction Corner Record filed with the County Surveyor.

B. Locate and clearly flag trees and vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to City Representative.

3.4 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.5 TREE PROTECTION

A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within fenced area.
2. Do not permit vehicles, equipment, or foot traffic within fenced area.
3. Maintain fenced area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

1. Cover exposed roots with burlap and water regularly.
2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
3. Coat cut faces of roots more than 1-1/2 inches in diameter with emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
4. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by City's Representative.

1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
2. Replace trees that cannot be repaired and restored to full-growth status, as determined by City's Representative.

3.6 UTILITIES

A. Existing utility lines shall be removed as indicated on plans. Prior to their removal, all required new re-routing and new connections shall be completed and made operative so that their functions to other existing structures served by them can be continuous and uninterrupted. Abandoned utility lines encountered during construction shall be removed.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by City of Fontana Development Services Organizational Building or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify City's Representative not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without City's Representative written permission.

C. Excavate for and remove underground utilities indicated to be removed.

D. Removal of underground utilities is included in Division 2 Sections covering site utilities.

3.7 USE OF EXPLOSIVES:

A. Use of explosives will not be permitted.

3.8 CLEARING AND GRUBBING

A. The limits of clearing and grubbing shall be the area of new construction

B. Remove all trash, rubbish and all other material not suitable for construction operations.

1. Remove trees, shrubs, grass, and other vegetation to permit installation of new construction.
2. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
3. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
4. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
5. Use only hand methods for grubbing within tree protection zone.
6. Chip removed tree branches and dispose of off-site.

C. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.9 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within tree protection zones.
3. Dispose of excess topsoil as specified for waste material disposal.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.10 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.11 DISPOSAL

A. All removed and demolished material, including but not limited to concrete, asphalt concrete, trees, brush, vegetation and trash resulting from the work of this section is the property of the Contractor and shall be promptly removed to a legal disposal area off campus. Asphalt and concrete shall not be used as fill material unless otherwise noted.

1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 31 10 00

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SECTION 31 22 00

GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade, walks and pavements.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase and base course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling for utility trenches.
8. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

B. Related Sections include the following:

1. Division 1 Section "Allowances" for quantity allowance provisions related to unit-price rock excavation and authorized additional excavation.
2. Division 1 Section "Unit Prices" for unit-price rock excavation and authorized additional excavation provisions.
3. Division 1 Section "Field Engineering" for recording preexcavation and earthwork progress.
4. Division 1 Section "Construction Facilities And Temporary Controls" for temporary controls, utilities, and support facilities.
5. Division 2 Section "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
6. Division 2 Section "Tree Protection and Trimming" for protecting and trimming trees to remain.
7. Division 2 Section "Subdrainage" for drainage of foundations and walls.
8. Division 2 Section "Lawns and Grasses" for finish grading, including preparing and placing topsoil and planting soil for lawns.
9. Division 2 Section "Exterior Plants" for planting bed establishment and tree and shrub pit excavation and planting.

1.2 UNIT PRICES

A. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.

1. 24 inches outside of concrete forms other than at footings.
2. 12 inches outside of concrete forms at footings.
3. 6 inches outside of minimum required dimensions of concrete cast against grade.
4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
5. 6 inches beneath bottom of concrete slabs-on-grade.
6. 6 inches beneath pipe in trenches.

1.3 REFERENCED STANDARDS:

A. The editions, specifications and standards referenced herein, published by the following organizations apply to the construction only to the extent specified by the reference.

B. Standard Specifications:

1. Standard Specifications for Public Works Construction (current edition).
2. Standard Special Provisions of the Regional Standards Committee.
3. California Department of Transportation, "Manual of Traffic Controls, for Construction and Maintenance Work Zones", (current edition), Document No. 869159.

C. Standard Drawings:

1. City of Fontana Standard Plans, (current edition).

D. The publications listed below form a part of this specification to the extent referenced. The publications are referred to the text by basis designation only.

1. American Society for Testing and Materials (ASTM) Publications:
2. C 33-86 Concrete Aggregates
3. C 136-84a Sieve Analysis of Fine and Coarse Aggregates
4. D 4318-84 Liquid Limit, Plastic Limit and Plasticity Index of Soils
5. D 1140-54 Amount of Material in Soils Finer than the (R 1971)No. 200 (75 micrometer) Sieve
6. D 1556-82 Density of Soil Place by Sand Cone Method (R 1974)
7. D 1557-78 Moisture Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54 kg) Rammer and 18-in. (457mm) drop
8. D 2103-81 Polyethylene Film and Sheeting
9. D 2419-74 Sand Equivalent Value of Soils and Fine Aggregates (R 1979)
10. D 2487-85 Classification of Soils for Engineering Purposes
11. D 2922-81 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

E. D 3017-78Moisture Content of Soil and Soil-Aggregate in place by Methods (Shallow Depth)

1.4 DELIVERY AND STORAGE:

A. Deliver and store materials in a manner to prevent contamination or segregation.

1.5 RECORDS OF INVESTIGATION:

A. Refer to "Information Available to Bidders".

1.6 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by City's Representative. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by City's Representative. Unauthorized excavation, as well as remedial work directed by City's Representative, shall be without additional compensation.

G. Pipe Zone: The pipe zone shall include the full width of trench from the bottom of the pipe or conduit to a horizontal level 12 inches above the top of the pipe. 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 as described above unless otherwise shown on the Drawings or otherwise described in the specifications for the particular type of pipe installed.

H. Pipe Beading: The pipe bedding shall be defined as a layer of material below the bottom of the pipe or conduit as shown on the Drawings and extending over the full trench width in which the pipe is bedded. Use a minimum thickness of 6 inches for the pipe bedding unless otherwise shown on the Drawings or otherwise described in the specifications for the particular type of pipe installed.

I. Fill: Soil materials used to raise existing grades.

J. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 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, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,090 lbf and stick-crowd force of not less than 18,650 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 48,510-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.

K. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches] when tested by an independent geotechnical testing agency, according to ASTM D 1586.

L. 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.

M. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

N. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

O. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.7 SUBMITTALS

A. Product Data: For the following:

1. Each type of plastic warning tape.
2. Geotextile.
3. Controlled low-strength material, including design mixture.

B. Samples: 12-by-12-inch Sample of subdrainage geotextile.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 1557 for each on-site and borrow soil material proposed for fill and backfill.

D. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.8 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.

B. Preexcavation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Quality Control."

1.9 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by City of Fontana Development Services Organizational Building or others unless permitted in writing by City's Representative and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify City's Representative not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without City's Representative's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Materials for compact fill shall consist of any soil imported or excavated from the cut areas. The soil shall contain no rocks or hard lumps greater than 6 inches in maximum dimension and shall contain at least 40% of material smaller than 1/2 inch in size.

Material of perishable, spongy, or otherwise improper nature shall not be used in fills. Asphalt concrete pieces shall not be used in fill.

B. Native earth backfill used above the pipe zone shall be excavated, non-expansive, fine-grained material free of roots, debris, and rocks larger than 3 inches.

C. Materials placed within 36 inches of rough grade shall be select material as specified in Part 1 above. The material shall not swell more than 3% when compacted to 90% relative compaction in accordance with ASTM D 1557 under an axial load of 160 psf.

D. Representative samples of material to be used for fill shall be tested in the laboratory in the order to determine the maximum density, optimum moisture content and classification of the soil.

E. During the grading operations, soil types other than those analyzed in the report of the soil investigation may be encountered. The City's Geotechnical Engineer shall be consulted to determine the suitability of these soils.

F. Fill material to be used under the building, slabs, pavement, and structures shall be on-site or imported material, conforming to the above. Excavated on-site material will be considered suitable for structural fill if it is free from organic matter and other deleterious substances and conforms to the requirements specified above. No material shall be placed without the approval of the City's Representative under the direction of the City's Geotechnical Engineer.

G. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

H. Satisfactory Soils: [ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM] [AASHTO M 145 Soil Classification Groups A-1, A-2-4, A-2-5, and A-3], or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

I. Unsatisfactory Soils: Soil Classification Groups [GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487] [A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145], or a combination of these groups.

   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

J. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

   1. Base Course: Aggregates for base course shall conform to Section 26 of the Standard Specifications, Class 2 for 3/4 inch maximum size gradation.

K. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

L. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

M. Drainage Course: Narrowly graded mixture of washed 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.

N. 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.

O. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

P. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 IMPORTED SAND - PIPE ZONE:

A. Imported sand used in the pipe zone or for the pipe base shall have the following gradation:

1. Sieve Size Percent Passing By Weight

1)	3/8 inch	100
2)	No. 4	75 - 100
3)	No. 30	12 - 50
4)	No. 100	5 - 20
5)	No. 200	0 - 10

2.3 CRUSHED ROCK:

A. Use a 3/4 inch maximum crushed rock for pipe bedding for water, sewer, and storm drains, conforming to Section 200-1.2 of the Standard Specifications.

2.4 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
3. Sewn Seam Strength: 142 lbf; ASTM D 4632.
4. Tear Strength: 56 lbf; ASTM D 4533.
5. Puncture Strength: 56 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.5 per second, minimum; ASTM D 4491.

8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
4. Tear Strength: 90 lbf; ASTM D 4533.
5. Puncture Strength: 90 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.5 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

B. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 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. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing," during earthwork operations.

3.2 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.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 STAKING AND GRADES:

A. Lay out work, establish necessary markers, bench marks, grading stakes, and other stakes as required.

B. Existing and finish elevations are shown on the drawings, and unless inconsistencies therein are brought to the attention of the City's Representative in writing prior to commencement of the construction, the Contractor will be held responsible for the proper location and elevation of all work.

3.5 COMPACTED FILLS:

A. Excavate the trench to the lines and grades shown on the Drawings with allowance for pipe thickness and for pipe bedding. If the trench is excavated below the required grade, refill any part of the trench excavated below the grade at no additional cost to the University with crushed rock. Place the refilling material over the full width of trench in compacted layers not exceeding 6 inches deep to the established grade.

B. General: Unless otherwise specified, fill material shall be compacted while at a moisture content near the optimum moisture content and to a density that is not less than the maximum density determined in accordance with the ASTM D 1557 or other density methods that will obtain equivalent results. Relative compaction shall be as follows:

1. Top 12" subgrade under paved areas: 95%
2. All other areas: 90%

3.6 PREPARING AREAS TO BE FILLED:

A. Objectionable material shall be removed from the surface upon which the fill is to be placed and loose and porous soil shall be removed and compacted to the depths specified.

B. After the foundation has been cleared, plowed or scarified, it shall be disced or bladed until it is uniform and free from clods, brought to the proper moisture content and compacted as specified for fill.

3.7 PLACING, SPREADING, AND COMPACTING FILL MATERIAL:

A. The fill materials shall be placed in layers that when compacted shall not exceed 6". Each layer shall be spread evenly and be thoroughly mixed during the spreading to obtain uniformity of material in each layer.

B. When the moisture content of the fill material is above that specified, the fill material shall be aerated by the Contractor by blading, mixing or other satisfactory methods until the moisture content is as specified.

C. When the moisture content of the fill material is below that specified, water shall be added by the Contractor until the moisture content is as specified.

D. After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted to the specified density. Compaction shall be accomplished by sheepsfoot rollers, vibratory roller, multiple-wheel pneumatic-tired rollers or other types of acceptable compacting equipment. Equipment shall be of such design that it will be able to compact the fill to the specified density. Compaction shall be continuous over the entire area and the equipment shall make sufficient trips to insure that the desired density has been obtained throughout the entire fill.

E. After the subgrade has been compacted, the surface shall be reshaped to conform to the drawings and high or low spots eliminated. The finished subgrade shall be thoroughly compacted by rolling, vibrating and tamping to a uniform dense surface. The subgrade shall be protected from displacement by equipment or other operations.

F. Where fills are constructed on hillsides or slopes, topsoil, slopewash and colluvium shall be removed. Where the exposed slope is steeper than 6 horizontal to 1 vertical, or where specified, the slope on the original ground on which the fill is to be placed shall be stepped or benched. The bottom bench shall be a minimum of 15 feet wide, at least 2 feet deep, and expose firm material over the entire excavation. After excavation of existing ground or removal of unacceptable material at the exposed subgrade, scarify the surface and compact as described above. The City's Geotechnical Engineer will be afforded the opportunity to determine the width and frequency of all succeeding benches.

G. No asphalt concrete, Portland Cement Concrete or any other rubble shall be allowed in fill.

3.8 STRUCTURE EXCAVATION AND BACKFILL:

A. Structural excavation and backfill shall be done per Sections 300-3.1, 300-3.3, 300-3.4 and 300-3.5 of the Standard Specifications. Jetting shall not be permitted.

3.9 EXCAVATION, GENERAL

A. Excavate for foundations, pits, trenches, footings, floor slabs, concrete walks to the lines and levels required, shown on the drawings and specified herein, and provide shoring, bracing, cribbing, pumping, and planking required. The bottoms of trenches shall be level, tamped firm, clean and free from debris or foreign matter. Excavations shall be kept free from standing water at all times.

B. Excavated earth material which is suitable for structural fill or backfill, as determined by the City's Representative, shall be conditioned for re-use and properly stockpiled for later filling and backfilling operations. Conditioning shall consist of spreading in layers not to exceed 8 inches. Rocks and aggregate, exceeding 6" in the largest dimension, and deleterious material shall be removed from the site off campus to a legal disposal site.

C. Abandoned sewers, piping, and other utilities encountered in the progress of the excavation, shall be removed off campus to a legal disposal site.

D. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs on grade.
f. 6 inches beneath pipe in trenches.

E. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by City's Representative. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract time may be authorized for rock excavation.

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; if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

   a. 24 inches outside of concrete forms other than at footings.
   b. 12 inches outside of concrete forms at footings.
   c. 6 inches outside of minimum required dimensions of concrete cast against grade.
   d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
   e. 6 inches beneath bottom of concrete slabs on grade.
   f. 6 inches beneath pipe in trenches.

3.10 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.11 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.12 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Trench widths in the pipe zone shall be as shown on the Drawings. If no details are shown, maximum width shall be 18 inches greater than the pipe outside diameter. 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. Excavate the trench to the lines and grades shown on the Drawings with allowance for pipe thickness and for pipe bedding. If the trench is excavated below the required grade, refill any part of the trench excavated below the grade at no additional cost to the University with crushed rock. Place the refilling material over the full width of trench in compacted layers not exceeding 6 inches deep to the established grade.

D. Excavate trenches to uniform widths to provide the following 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 indicated.

1. Clearance: 12 inches each side of pipe or conduit or as indicated.

E. 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.

F. Trench Bottoms: 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.

3.13 LOCATION OF EXCAVATED MATERIAL:

A. During trench excavation, place the excavated material adjacent to the trench as directed by the City's Representative. Do not obstruct any roadways or streets. Conform to federal and state codes governing the safe loading of trenches with excavated material.

3.14 SUBGRADE INSPECTION

A. Notify City's Representative when excavations have reached required subgrade.

B. If City's Representative determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by City's Representative, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by rain, accumulated water, or construction activities, as directed by City's Representative, without additional compensation.

3.15 UNAUTHORIZED EXCAVATION

A. Over Excavation: If excavations for foundation work are made deeper than indicated, fill with same concrete as specified for foundation work, without additional expense to University. If excavations for foundation work are made wider than indicated, form footing work or fill with same concrete as specified for foundation work at no additional expense to University.

B. If excavations for slabs or flatwork are made deeper than indicated, fill with coarse, sand to required levels. Compact at optimum moisture content to 90 percent density.

C. If excavations to greater depths than shown are required by the Geotechnical Engineer in order to reach satisfactory soil bearing conditions, the City's Representative is to be notified.

D. Surplus materials may not be disposed of on site and must be disposed of off campus in a legal disposal area per Section 300-2.6 of the Standard Specifications. Surplus soil may not be exported to a K-12 school site or to a residential site.

3.16 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory 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. Do not store within drip line of remaining trees.

3.17 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.

2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting 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.

B. Place backfill on subgrades free of mud.

3.18 UTILITY TRENCH BACKFILL

A. Conform to Standard Plan No. 2009 for bedding for PVC sewer.

B. Place backfill on subgrades free of mud.

C. Backfill per the detailed piping specification for the particular type of pipe and per the following.

D. Place the specified thickness of pipe bedding material over the full width of trench. Grade the top of the pipe bedding ahead of the pipelaying to provide firm, uniform support along the full length of pipe.

E. Excavate bell holes at each joint to permit proper assembly and inspection of the entire joint.

F. After pipe has been bedded, place pipe zone material simultaneously on both sides of the pipe (maximum lift thickness 6") 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 backfilling.

G. Compact material placing within 12 inches of the outer surface of the pipe by hand tamping only.

H. Push the backfill material carefully into the backfill previously placed in the pipe zone (maximum lift thickness 6"). Do not permit free fall of the material until at least 2 feet 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.

I. 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.

J. Unless otherwise shown on the Drawings or otherwise described in the specifications for the particular type of pipe installed, relative compaction in pipe trenches shall be as follows:

1. Pipe zone: 90% relative compaction.

2. Backfill above pipe zone not beneath paving: 90% relative compaction.
3. Backfill above pipe zone in repaved areas: 95% relative compaction for top 24 inches; 90% relative compaction for backfill below 24 inches.
4. Backfill above pipe zone in new pavement areas: 95% relative compaction for top 12 inches; 90% relative compaction for backfill below 12 inches.

K. Compact trench backfill to the specified relative compaction. Compact by using mechanical compaction or hand tamping. Do not use high impact hammer-type equipment except where the pipe manufacturer warrants in writing that such use will not damage the pipe.

L. Do not use any axle-driven or tractor-drawn compaction equipment within 5 feet of walls and structures.

M. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 3 Section "Cast-in-Place Concrete."

N. 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.

O. Place and compact initial backfill of subbase material or satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

P. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the utility pipe or conduit.

Q. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

R. Place and compact final backfill of satisfactory soil to final subgrade elevation.

S. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

T. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.19 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. 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.

C. Place soil fill on subgrades free of mud.

3.20 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy.
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.

3.21 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil 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 soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials 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 soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent.

3.22 MATERIAL REPLACEMENT:

A. Remove and replace any trenching and backfilling material which does not meet the specifications, at the Contractor's expense.

3.23 FINISH GRADING:

A. General: Fine grade to bring areas to required lines and grades. The subgrade elevation within the building area for slabs on grade shall be within 1/2" along a 10"-0" straight edge.

B. Slope finish grades to drain surface water away from buildings, walks. Generally, grade with uniform slope between points where elevations are given, or between such points and existing grades.

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.

C. 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.
2. Walks: Plus or minus 1/2 inch, except for ADA areas there is no tolerance.
3. Pavements: Plus or minus 1/2 inch, except for ADA areas there is no tolerance.

D. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.24 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Division 2 Section "Subdrainage."

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.
2. Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

3.25 SUBBASE AND BASE COURSES

A. Place subbase and base course on subgrades free of mud.

B. On prepared subgrade, place subbase and base course under pavements and walks as follows:

1. Place base course material over subbase course under hot-mix asphalt pavement.
2. Shape subbase[and base] course to required crown elevations and cross-slope grades.
3. Place subbase and base course 6 inches or less in compacted thickness in a single layer.
4. Place subbase and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
5. Compact subbase and base course 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.

C. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.26 DRAINAGE COURSE

A. Place drainage course on subgrades free of mud.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.27 FIELD QUALITY CONTROL

A. Testing Agency: University will engage 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. The Contractor shall conduct his operations to permit tests to be made without interference from his forces and equipment. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. When tests indicate that the density of any layer of fill or portion thereof is below the specified density, such layer or portion shall be re-worked and re-tested until the specified density has been obtained. Re-testing shall be paid for by the Contractor.

D. No more than two feet of fill in vertical elevation shall be placed without at least one field density test being made within that interval.

E. Samples: Submit at least one 50-pound composite sample for each 500 cubic yards of embankment material being placed. Samples, in the number directed, shall also be submitted whenever the source or character of the embankment material changes. Each sample shall be taken in three increments from the same truck one increment from the first third of the load, one when half of the load has been dumped, and one from the final third of the load during dumping of the material.

F. Each sample shall be contained in a clean container which shall be fastened to prevent loss of material. Each sample shall be tagged for identification. The tag shall contain the following information:

1. Project No.
2. Sample No.
3. Date of Sample
4. Sampler
5. Source
6. Intended Use

G. 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 City's Representative.

H. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2099/D 3017, ASTM D 2167, ASTM D 2922, and ASTM D 2937, 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 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length, but no fewer than 2 tests.
4. In paved areas, one density test will be taken for each 2,000 square feet of subgrade in cut.
5. The City reserves the right to take more tests as required.

I. 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.

3.28 PROTECTION

A. During construction, properly graded excavated surfaces to provide positive drainage and prevent ponding of water. Control surface water to avoid damage to adjoining properties, or to finished work on the site. Take remedial measures to prevent erosion of freshly graded areas and slopes, until such time as permanent drainage and erosion control measures have been installed.

B. After completion of grading and the City's Representative has finished observations of the work, no further excavation or filling shall be done except under the observation of the City's Representative.

C. Erosion prevention shall continue through the duration of the project. Any debris or washouts deposited at bottom of slope of graded areas shall be replaced immediately and reworked to proper compaction requirements.

D. Protecting Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

E. 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.

1. Scarify or remove and replace soil material to depth as directed by City's Representative; reshape and recompact.

F. 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 greatest extent possible.
2. Protect open excavations, trenches, and the like with fences, covers, and railings as required to maintain safe pedestrian and vehicular traffic passage. Prevent erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

3.29 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 City's property.

3.30 EXISTING UTILITIES:

A. Existing utilities are shown from available records and the accuracy of their location cannot be guaranteed. The Contractor shall pothole as necessary to locate horizontally and vertically all existing utilities. Any discrepancy from the plans shall be reported to the City's Representative immediately. The Contractor shall be responsible for all costs due to discrepancies in the location of existing utilities if the Contractor fails

to pothole and locate existing utilities and notify the City's Representative of discrepancies prior to start of construction.

B. Abandoned utilities encountered during all construction operations shall be removed as required to complete all work shown on plans.

C. Live utilities shall remain in service at all times unless otherwise noted.

3.31 COMPLETION REQUIREMENTS:

A. Cleanup: Leave entire graded portions of the site "rake-clean".

B. Disposal: Pick up and transport unsuitable, deleterious, excess material, and debris to an off-site legal disposal area.

END OF SECTION 31 22 00

SECTION 32 05 10

IMPORTED SOIL & ROCK

PART 1- GENERAL

1.1 SUMMARY:

A. Delivery and placement of imported soil and rock in landscape areas where indicated on the plans and detailed drawings.

1.2 . References and Standards

A. The following references are used herein and shall mean: ASTM: American Society of Testing Materials USDA: United States Department of Agriculture AASHTO: American Association of State Highway and Transportation Officials Standard Specifications: Regional or Municipal Standard Specifications Documentation for the location of proposed usage AOAC: Association of Official Agricultural Chemists

1.3 RELATED SECTIONS:

A. 328400 Irrigation

B. 329000 Landscaping

1.4 SAMPLES AND SUBMITTALS:

A. Submit cut sheets for each specified soil & rock type.

B. Submit soil test analysis reports for sample of clay loam from an independent soil-testing laboratory. The testing laboratory for particle size and chemical analysis may include a public agricultural extension service agency.

a. Submit a mechanical analysis of the clay loam sample and particle size analysis including the following gradient of mineral content:

USDA Designation	Size in mm.
Gravel	+2 mm
Sand	0.05 – 2 mm
Silt	0.002-0.05 mm
Clay	minus 0.002 mm

Sieve analysis shall be performed and compared to USDA Soil Classification System.

Sieve analysis shall be done by a combined hydrometer and wet sieving using sodium hexametaphosphate as a dispersant in compliance with ASTM D422 after destruction of organic matter by hydrogen peroxide.

b. Submit a chemical analysis, performed in accordance with current AOAC Standards, including the following:
   i. pH and buffer pH.

ii. Percent organic matter as determined by the loss of ignition of oven dried samples. Test samples shall be oven dried to a constant weight at a temperature of 230 degrees F, plus or minus 9 degrees.
iii. Analysis for nutrient levels by parts per million.
iv. Soluble salt by electrical conductivity of a 1:2 soil/water sample measured in Millimho per cm. e. Cation Exchange Capacity (CEC).
v. Carbon/Nitrogen Ratio.

C. Submit one pint sample of mineral mulch.

D. Submit cut sheet for Engineered Biofiltration Soil

E. Any deviation from the specified crushed stone and clay loam specifications shall be approved by the landscape architect prior to ordering and installation.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver soil and mineral mulch to site in bulk shipments and store in location(s) where it will not require relocation prior to placement.

B. Protect soil and mineral mulch from wind and rain with water repellent covers, weighted with masonry or rock.

1.6 EXAMINATION OF CONDITIONS

A. All areas to receive CU-Structural Soil® shall be inspected by the installing contractor before starting work and all defects such as incorrect grading, compaction, and inadequate drainage shall be reported to the engineer prior to beginning this work.

1.7 QUALITY ASSURANCE

A. Qualifications of installing contractor: The work of this section should be performed by a licensed landscape contractor.

PART 2- PRODUCTS

2.1 MATERIALS:

A. MINERAL MULCH
a. Mineral mulch shall be derived from decomposing granitic sources, 3/8” in diameter.
b. Golden tan and brown color.

B. CLAY LOAM

a. Soil shall be a “loam” with a minimum clay content of 20% or a “clay loam” based on the “USDA classification system” as determined by mechanical analysis (ASTM D-422) and it shall be of uniform composition, without admixture of subsoil. It shall be free of stones, lumps, plants and their roots, debris and other extraneous matter. It shall not contain toxic substances harmful to plant growth. Clay loam shall contain not less than 2% or more than 5% organic matter as determined by the loss on ignition of oven-dried samples. Test samples shall be oven-dried to a constant weight at a temperature of 230 degrees F., plus or minus 9 degrees.

b. Mechanical analysis for the loam or clay loam shall be as follows:

Textural Class	% of Total Weight
Gravel	less than 5%
Sand	20-45%
Silt	20-50%
Clay	20-40%

c. Chemical analysis: Meet, or be amended to meet the following criteria:

i. pH between 5.5 to 6.5
ii. Percent organic matter 2% - 5% by dry weight
iii. Adequate nutrient levels
iv. Soluble salt less than 1.0 mmho/cm
v. Cation Exchange Capacity (CEC) greater than 10
vi. Carbon/Nitrogen ratio less than 33:1

C. Clay loam shall not be mined from riverbeds and shall not be derived from USDA-classified prime farmland.

2.2 FERTILIZER (if needed)

A. Should nutrient analysis suggest that the loam or clay loam need additional nutrients, it shall be amended by the Contractor prior to installation.

2.3 SULFUR (if needed)

A. Sulfur shall be a commercial granular, 96% pure sulfur, with material and analysis appearing on the labeled container.
B. Sulfur used to lower pH shall be a ferrous sulfate formulation.
C. Application rates shall be dependent on soil test results.

2.4 LIME (if needed)

A. Agricultural lime containing a minimum of 85% carbonates.
B. Application rates shall be dependent on soil test results.

2.5 MINERAL MULCH

A. The size of the crushed stone shall be 3/8” inch, allowing for up to 10% being greater or less.
B. The mineral mulch shall be derived from granitic sources and tan – brown in color.

2.6 ENGINEERED BIOFILTRATION SOIL

A. Engineered soil in stormwater treatment structure:

1. Shall be a biologically-active, engineered growing medium meeting the following specifications:

Pore Space		
Soil Bulk Density	Lbs/cu. ft.	85.8
KSat (percolation rate)	In./hr.	8.6
Capillary (by volume)	%	10
Non-capillary (by volume)	%	40
Total Pore Space	%	35
Moisture Retained (by weight)	%	7
Soil Properties		
Capillary (by volume)	cu.in/ cu.ft.	171
Non-capillary (by volume)	%	696
Moisture Capacity		
Saturation (3.4 gallons)	Lbs/cu. ft.	28.1
Moisture Retained (2.6 gallons)	Lbs/cu. ft.	6.2
Organic Measurements		
Organic matter content	DryWt. %	5.0
pH and Salt Content		
pH range		6.5 – 7.5
ECe (Salinity)		1.0-3.0

PART 3- EXECUTION

3.1 INSTALLATION:

A. CLAY LOAM:

a. In landscape areas where shown on the drawings distribute amended soil in the depths specified on the plans evenly.
b. Install weed barrier per the detailed drawings.

c. See plans and details for landscape drains.

B. MINERAL MULCH:

a. Install mineral mulch at the specified depth in each planting area to receive it where shown on the plans, after planting operations and all other construction activities are complete. It shall be the responsibility of the installing contractor to verify with the Construction Manager that the work of other trades is complete prior to installing mineral mulch.
b. Rake mulch evenly throughout planting areas, tapering up to within 3" of plant rootball crown. Do not allow mulch to rest against plant stem or trunk.

C. BIOFILTRATION SOIL:

a. Imported backfill material for the bioretention zones should be placed in a relatively loose condition, no rolling or other heavy equipment, to promote the planned infiltration of water, through the bioretention soil mix layer.

b. Bioretention soil shall be installed in six (6) to twelve (12) inch lifts and thoroughly watered to provide settlement and natural compaction. No mechanical compaction is allowed. After natural compaction has been completed, add, if needed, additional bioretention soil to proposed finish grade as indicated on the plans.

c. Rake bioretention soil as needed to level out.

d. Vehicular traffic, construction equipment shall not drive-on, move onto, or disturb the bioretention soil once placed and water compacted.

e. Erosion and Sediment Control practices during construction shall be employed to protect the long-term functionality of the bioretention basin/swale. The following practices shall be followed for this reason:

1. Provide erosion control in the contributing drainage areas to the facility and stabilize upslope areas.

2. Do not use facilities as sediment control facilities, unless installation of all bioretention-related materials are withheld towards the end of construction allowing the temporary use of the location as a sediment control facility, and appropriate excavation of sediment is provided prior to installation of bioretention materials.

3. Place a three inch layer of organic mulch on the surface of the bioretention soil unless otherwise indicated on the Drawings.

3.2 FINE GRADING

A. After the initial placement and rough grading of the soil but prior to the start of fine grading, the installing contractor shall request review of the rough grading by the engineer. The installing contractor shall set sufficient grade stakes for checking the finished grades.
B. Adjust the finish grades to meet field conditions as directed. Provide smooth transitions between slopes of different gradients and direction.

3.3 ACCEPTANCE STANDARDS

A. The Landscape Architect will inspect the work upon the request of the installing contractor. Request for inspection shall be received by the engineer at least 10 days before the anticipated date of inspection.

3.7 CLEAN-UP

A. Keep all areas of work clean, neat and orderly at all times.

B. Upon completion of work, remove off the site all surplus materials, tools, equipment, rubbish and debris resulting from the work and dispose of legally offsite.

C. Sweep all paving and other exposed surfaces of dirt and mud.

END OF SECTION 32 05 10

SECTION 32 12 16

ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving overlay.
4. Asphalt surface treatments.
5. Pavement-marking paint.
6. Cold milling of existing hot-mix asphalt pavement.

B. Related Sections include the following:

1. Division 2 Section "Earthwork" for aggregate subbase and base courses and for aggregate pavement shoulders.
2. Division 2 Section "Pavement Joint Sealants" for joint sealants and fillers at paving terminations.
3. Division 2 Section "Unit Pavers" for bituminous setting bed for pavers.

1.2 REFERENCED STANDARDS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. State of California, Department of Transportation:

a. Current Edition; Standard Specifications.

2. American Society for Testing and Materials (ASTM) Publications:

a. D 2172-81 - Quantitative Extraction of Bitumen from Bituminous Paving Mixtures.

3. Standard Specifications for Public Works Construction (Greenbook):

a. 2024 Edition.

1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. DOT: Department of Transportation.

C. SSPWC: Standard Specifications for Public Works Construction (Greenbook).

1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of state or local DOT.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

1. Prepare mix design; sample and test materials and equipment for compliance with the specifications. Properly mark samples to show the name of the material, name of the supplier, contract number and the segment of the work where the material represented by the sample is to be used. Submit copies of weighmaster's certificates or certified delivery tickets for each truck load of material.
2. Certificates: Submit manufacturer's certificate of compliance for the bituminous and paint materials.
3. Job-Mix Formula: Submit a job mix for each type of bituminous mixture prior to starting work. The formula shall be within the specified design range.

C. Qualification Data: For manufacturer.

D. Material Test Reports: For each paving material.

E. Material Certificates: For each paving material, signed by manufacturers.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.

C. Regulatory Requirements: Comply with Caltrans specifications for asphalt paving work.

D. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Tack Coats: Minimum surface temperature of 60 deg F.
2. Slurry Coat: Comply with weather limitations of ASTM D 3910.
3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 50 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

1. The grading and proportioning of aggregates shall be such that the combined mineral aggregate conforms to the specified requirements.

B. Aggregate for asphaltic concrete shall conform to Section 39 of the Standard Specifications, Class B for individual test result conforming to 1/2 inch maximum size gradation for surface course and ¾ inch maximum size gradation for base course.

C. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or properly cured, crushed blast-furnace slag.

D. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, properly cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

E. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Cement: ASTM D 3381 for viscosity-graded material or ASTM D 946 for penetration-graded material.

1. Asphalt Cement: Section 92 of the Standard Specifications, Grade PG-70-10 for parking lots and PG-64-10 for streets.

B. Tack Coat: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

C. Fog Seal: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

D. Water: Potable.

E. Undersealing Asphalt: ASTM D 3141, pumping consistency.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

B. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

C. Sand: ASTM D 1073, Grade Nos. 2 or 3.

D. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.

E. Joint Sealant: ASTM D 3405, hot-applied, single-component, polymer-modified bituminous sealant.

F. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed.

1. Paint shall be reflectorized white or blue traffic paint, and conforming to the requirements of the Standard Specifications, State of California, Department of Transportation.

G. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than 3 minutes.

H. Glass Beads: AASHTO M 247, Type 1.

I. Fire Hydrant Markers: Double-faced blue reflective pavement markers with optical grade methyl methacrylate lenses, or equal.

1. Dimensions: 4 inches by 4 inches by 3/4-inch high.

J. Wheel Stops: Precast, air-entrained concrete, 4000-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners and holes for anchoring to substrate.

1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

K. Seal Coat: Emulsified asphalt with a minimum 2 percent to 3 percent latex or copolymer added. Utilize GuardTop High Performance Asphalt Based Sealcoat meeting Greenbook 203-9 specification or approved equal.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. The bituminous concrete shall consist of mineral aggregate, uniformly mixed with bituminous material in a central plant in accordance with Section 39 of the Standard Specifications. The percentage of asphalt cement binder shall be in accordance with Section 39 of the Standard Specifications. The mixing plant and construction equipment shall conform to the requirements of Section 39 of the Standard Specifications.

B. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction.

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Provide mixes complying with composition, grading, and tolerance requirements in ASTM D 3515 for the following nominal, maximum aggregate sizes:

a. Base Course: 3/4 inch.
b. Surface Course: 1/2 inch.

C. Emulsified-Asphalt Slurry: ASTM D 3910, Type X, consisting of emulsified asphalt, fine aggregate, and mineral fillers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 2 inches.
2. Mill to a uniform finished surface free of gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.

4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Transport milled hot-mix asphalt to asphalt recycling facility.
7. Keep milled pavement surface free of loose material and dust.

3.3 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slabs until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

E. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.4 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.5 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.6 PAVING GEOTEXTILE INSTALLATION

A. Apply tack coat uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd..

B. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.

1. Protect paving geotextile from traffic and other damage and place hot-mix asphalt paving overlay the same day.

3.7 HOT-MIX ASPHALT PLACING

A. Deliver bituminous mixtures to the roadbed at temperatures specified in Section 39 of the Standard Specifications. Spread in accordance with Section 39 of the Standard Specifications. Cover all loads with tarpaulin or other material during transportation.

B. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at minimum temperature of 250 deg F.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

C. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

D. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.8 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.9 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Initial or breakdown rolling and the final rolling of the uppermost layer of the asphalt concrete shall be in accordance with Section 39 of the Standard Specifications. Compaction by vehicular traffic shall not be permitted.
2. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Joining Pavement: Carefully make joints between old and new pavements or between successive day's work made in such manner as to insure a continuous bond between old and new sections of the course. Expose and clean edges of existing pavement. Cut edge to straight, vertical surfaces. Paint all joints with a uniform coat of tack coat before the fresh mixture is placed. Prepare joints in the new pavement in accordance with Section 39 of the Standard Specifications.

G. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

H. Protection of Pavement: After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until it has cooled and hardened and in no case less than 6 hours.

I. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch, except for ADA areas where there is no tolerance.

3.11 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F.

1. Asphalt Mix: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.12 SURFACE TREATMENTS

A. Seal Coat: Apply first coat at rate of 0.125 to 0.185 gal./sq. yd. After first coat has dried, apply second coat at rate of 0.100 to 0.185 gal./sq. yd. Follows manufacturer’s recommendations for 2-coat installation.

1. Seal coating new pavements should be delayed 30 days after installation or as recommended by manufacturer.

2. Preparation: All area shall be power-swept, vacuumed and cleared of loose material.
3. Standing water shall be spread out and allowed to dry. Do not apply seal coat to wet or damp surfaces.
4. Oil spots shall be manually scraped and cleaned with a mild detergent. Apply primer over highly saturated petroleum areas.
5. Cover and protect items within paved area that are not to be coated, such as valve boxes, manholes and concrete.
6. If asphalt must be striped prior to sealer, contractor shall account for sealer application and a subsequent restripe of any striping obscured by sealer.

B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.

1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.13 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with City's Representative.

B. Requirements: The work shall consist of applying painted stripes and markings in accordance with Section 84 of the Standard Specifications.

C. General: All pavement striping and marking shall be given two coats of water borne paint. Repaint existing markings damaged by construction.

D. Weather Limitations: Apply paint only when the pavement is dry. Paint shall not be applied when the atmospheric temperature is below 50 degrees nor under unfavorable conditions.

E. Allow paving to age for 7 days before starting pavement marking.

F. Sweep and clean surface to eliminate loose material and dust.

G. 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. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6 lb/gal..

3.14 FIRE HYDRANT MARKERS

A. Install markers to identify each new or relocated fire hydrant. Locate marker approximately 12 inches from the center stripe of a striped road, or 18 inches from the centerline of the travel lanes on a road without center striping, towards the side where the fire hydrant is located.

B. Affix marker to pavement using epoxy adhesive specifically intended for such use.

3.15 WHEEL STOPS

A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.16 INSPECTION OF PLANT AND EQUIPMENT

A. The City's Representative shall have access at all times to all parts of the batch plant for checking the adequacy of the equipment in use, inspecting the operation of the plant, verifying weight, proportions and character of materials and checking temperatures being maintained in the preparation of the mixture.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: University will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

1. The in-place density of compacted base course will be determined. No payment will be made for the areas of pavement deficient in composition, density or thickness until they are removed and replaced. Determine maximum density in accordance with ASTM D 1557, Method D. Perform in place density tests in accordance with ASTM D 1556.
2. The asphalt content in percent by extraction in accordance with ASTM D 2172, Method A will be determined.
3. The field density of compacted asphalt concrete shall be determined by a properly calibrated nuclear asphalt testing device.
4. Compaction tests to be at a rate determined by the University for each lift or course of asphalt concrete placed.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.18 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow excavated materials to accumulate on-site.

END OF SECTION 32 12 16

SECTION 32 13 13

CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:

1. Driveways and roadways.
2. Parking lots.
3. Curbs and gutters.
4. Walkways.
5. Unit paver base.

B. Related Sections include the following:

1. Division 2 Section "Earthwork" for subgrade preparation, grading, and subbase course.
2. Division 2 Section "Pavement Joint Sealants" for joint sealants of joints in concrete pavement and at isolation joints of concrete pavement with adjacent construction.
3. Division 2 Section "Stamped Cement Concrete Pavement" for surface-imprinted, stamped finished concrete pavement.
4. Division 3 Section "Cast-in-Place Concrete" for general building applications of concrete.

1.2 REFERENCED STANDARDS

A. The editions and specifications and standards referenced herein, published by the following organizations apply to the construction only to the extent specified by the reference.

1. Standard Specifications:

a. Standard Specifications for Public Works Construction (current edition).
b. Standard special provisions of the Regional Standards Committee.
c. California Department of Transportation, "Manual of Traffic Controls, for Construction and Maintenance Work Zones," (current edition), Document No. 869159 (current date).
d. Standard Drawings: City of Fontana Standard Plans, (current edition).

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Product Data: Manufacturer's product data with application and installation instructions for proprietary materials and items such as admixtures, curing materials, and joint systems.

B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

D. Field quality-control test reports.

E. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Mockups: Cast mockups of full-size sections of concrete pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship.

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by City's Representative.
2. Notify City's Representative seven days in advance of dates and times when mockups will be constructed.
3. Obtain City's Representative's approval of mockups before starting construction.
4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
5. Demolish and remove approved mockups from the site when directed by City's Representative.
6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings" and Quality Control."

1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:

a. Contractor's superintendent.
b. Concrete pavement subcontractor.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with a radius 100 feet or less.

B. 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.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

C. Epoxy-Coated Welded Wire Fabric: ASTM A 884/A 884M, Class A, plain steel.

D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

H. Plain Steel Wire: ASTM A 82.

I. Deformed-Steel Wire: ASTM A 496.

J. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain.

K. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain steel bars.

M. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

N. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

O. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

P. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

Q. Zinc Repair Material: ASTM A 780.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Concrete shall be 560-C-3250 per Section 201-1 of the Standard Specifications
2. Concrete for curbs and gutters shall be Class 560-C-3250 per Section 201-1 of the Standard Specifications.
3. Concrete for cross gutters shall be Class 560-C-3250 per Section 201-1 of the Standard Specification.

4. Portland Cement: ASTM C 150, Type II/V, gray.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar pavement applications and service conditions using similar aggregates and cementitious materials.

1. Coarse-Aggregate Size: ¾ to 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:

1. Aggregate Sizes: 3/8 to 5/8 inch nominal.
2. Aggregate Source, Shape, and Color: Per Plans.

D. Water: ASTM C 94/C 94M.

E. Air-Entraining Admixture: ASTM C 260.

F. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

1. Products:

a. Axim Concrete Technologies; Cimfilm.
b. Burke by Edeco; BurkeFilm.
c. ChemMasters; Spray-Film.
d. Conspec Marketing & Manufacturing Co., Inc.; Aquafilm.
e. Dayton Superior Corporation; Sure Film.
f. Euclid Chemical Company (The); Eucobar.
g. Kaufman Products, Inc.; Vapor Aid.
h. Lambert Corporation; Lambco Skin.
i. L&M Construction Chemicals, Inc.; E-Con.
j. MBT Protection and Repair, ChemRex Inc.; Confilm.
k. Meadows, W. R., Inc.; Sealtight Evapre.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
n. Sika Corporation, Inc.; SikaFilm.
o. Symons Corporation; Finishing Aid.
p. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

1. Products:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. Burke by Edoko; Aqua Resin Cure.
c. ChemMasters; Safe-Cure Clear.
d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
f. Euclid Chemical Company (The); Kurez DR VOX.
g. Kaufman Products, Inc.; Thinfilm 420.
h. Lambert Corporation; Aqua Kure-Clear.
i. L&M Construction Chemicals, Inc.; L&M Cure R.
j. Meadows, W. R., Inc.; 1100 Clear.
k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
l. Symons Corporation; Resi-Chem Clear.
m. Tamms Industries Inc.; Horncure WB 30.
n. Unitex; Hydro Cure 309.
o. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

F. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.

1. Products:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 WP WB.
b. Burke by Edoco; Resin Emulsion White.
c. ChemMasters; Safe-Cure 2000.
d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
e. Dayton Superior Corporation; Day-Chem White Pigmented Cure (J-10-W).
f. Euclid Chemical Company (The); Kurez VOX White Pigmented.
g. Kaufman Products, Inc.; Thinfilm 450.
h. Lambert Corporation; Aqua Kure-White.
i. L&M Construction Chemicals, Inc.; L&M Cure R-2.
j. Meadows, W. R., Inc.; 1200-White.
k. Symons Corporation; Resi-Chem White.
l. Tamms Industries, Inc.; Horncure 200-W.
m. Unitex; Hydro White.
n. Vexcon Chemicals, Inc.; Certi-Vex Enviocure White 100.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

1. Use a preformed asphalt-impregnated expansion joint filler 1/2 inch thick for curbs and sidewalks conforming to Section 201-3.2 of the Standard Specifications.

B. Expansion Joint Sealer:

1. Expansion joint sealer shall be a two part polysulfide sealant conforming to Federal Specification TT-S-00227, Class A, self-leveling, colored to match the concrete.

C. Finish Coat:

1. Finish coat shall consist of Class B mortar per subsection 201.5.1 of the Standard Specifications.

D. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.

1. Manufacturers:

a. Bayer Corporation.
b. ChemMasters.
c. Conspec Marketing & Manufacturing Co., Inc.
d. Davis Colors.
e. Elementis Pigments, Inc.
f. Hoover Color Corporation.
g. Lambert Corporation.
h. Scofield, L. M.Company.
i. Solomon Colors.

E. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

F. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

G. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:

1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

H. Chemical Surface Retarder: Water-soluble, liquid-set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

1. Products:

a. Burke by Edeco; True Etch Surface Retarder.
b. ChemMasters; Exposee.
c. Conspec Marketing & Manufacturing Co., Inc.; Delay S.
d. Euclid Chemical Company (The); Surface Retarder S.
e. Kaufman Products, Inc.; Expose.
f. Metalcrete Industries; Surftard.

g. Nox-Crete Products Group, Kinsman Corporation; Crete-Nox TA.
h. Scofield, L. M. Company; Lithotex.
i. Sika Corporation, Inc.; Rugasol-S.
j. Vexcon Chemicals, Inc.; Certi-Vex Envioset.

I. Pigmented Mineral Dry-Shake Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Products:

a. Conspec Marketing & Manufacturing Co., Inc.; Conshake 600 Colortone.
b. Dayton Superior Corporation; Quartz Tuff.
c. Euclid Chemical Company (The); Surflex.
d. Lambert Corporation; Colorhard.
e. L&M Construction Chemicals, Inc.; Quartz Plate FF.
f. MBT Protection and Repair, ChemRex Inc.; Mastercron.
g. Metalcrete Industries; Floor Quartz.
h. Scofield, L. M. Company; Lithochrome Color Hardener.
i. Symons Corporation; Hard Top.

J. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch sieve and 85 percent retained on a No. 8 sieve.

2.7 PAVEMENT MARKINGS

A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed.

B. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than 3 minutes.

C. Glass Beads: AASHTO M 247, Type 1.

2.8 FIRE HYDRANT MARKERS

A. Double-faced blue reflective pavement markers with optical grade methyl methacrylate lenses, or equal.

1. Dimensions: 4 inches by 4 inches by 3/4-inch high.

2.9 WHEEL STOPS

A. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners and holes for anchoring to substrate.

1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

2.10 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Minimum Compressive Strength (28 Days): 3250 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
3. Slump Limit: 4 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size.
2. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.
3. Air Content: 6 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical 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.

F. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.11 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 deg F 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.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete mixes of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete mixes larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

1. Preparation of subgrade: The subgrade shall be prepared per Section 301-1 of the Standard Specification.

B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch] require correction according to requirements in Division 2 Section "Earthwork."

C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
2. Provide tie bars at sides of pavement strips where indicated.
3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
5. 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.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Expansion joints shall be located at 60' intervals and as required by Standard Plan 1000. Joints shall be constructed per Standard Plan 1006 and per Section 303-5 of the Standard Specifications.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent concrete pavement:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover 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 developing random contraction cracks.
3. Doweled Contraction 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.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Sidewalk: Construct sidewalk per Section 303-5 of the Standard Specifications.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by City's Representative.

J. Screed pavement surfaces with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

L. Curbs and Gutters:

1. Excavate and shape subgrade for curbs and gutters, to line, grade and cross section. Compact subgrade until the top 12 inches are compacted to 95% relative compaction. Remove all soft material disclosed by compacting and

replace with crushed rock base. The finished subgrade shall be within a tolerance of ± 0.08 of a foot of the grade and cross section shown and shall be smooth and free from irregularities at the specified relative compaction.

2. Set forms in accordance with Section 303-5.2 of the Standard Specifications. Tops of forms shall not depart from gradeline more than 1/8 inch when checked with a 10-foot straightedge. Alignment of straight sections shall not vary more than 1/8 inch in 10 feet.
3. Construct curb and gutters to line and grade shown per Section 303-5 of the Standard Specifications. Curb and gutters shall conform to the details shown on the Drawings and Standard Plans as called out on the plans.
4. Place performed asphalt-impregnated expansion joints and weakened plane joints as shown in Standard Plans 1000 and 1006. Joints shall conform with Standard Specification Section 303-5.
5. Finished curb shall present a uniform appearance for both grade and alignment. Remove any section of curb showing abrupt changes in alignment or grade or which is more than 1/4 inch away from the position required by the plans and construct new curb in its place at no additional cost to the University.

M. Curbs and Gutters Machine Placement:

1. When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

N. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

O. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

P. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

Q. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to 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. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 SPECIAL FINISHES

A. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in pavement surfaces as follows:

1. Immediately after float finishing, spray-apply chemical surface retarder to pavement according to manufacturer's written instructions.
2. Cover pavement surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
3. Without dislodging aggregate, remove excess mortar by lightly brushing surface with a stiff, nylon-bristle broom.
4. Fine-spray surface with water and brush. Repeat water flushing and brushing cycle until cement film is removed from aggregate surfaces to depth required.

B. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on pavement surface. Tamp aggregate into plastic concrete, and float finish to entirely embed aggregate with mortar cover of 1/16 inch.

1. Spray-apply chemical surface retarder to pavement according to manufacturer's written instructions.
2. Cover pavement surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
3. Without dislodging aggregate, remove excess mortar by lightly brushing surface with a stiff, nylon-bristle broom.
4. Fine-spray surface with water and brush. Repeat water flushing and brushing cycle until cement film is removed from aggregate surfaces to depth required.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on pavement surface according to manufacturer's written instructions and as follows:

1. Uniformly spread 40 lb/100 sq. ft. dampened slip-resistive aggregate over pavement surface in 2 applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
2. Uniformly distribute approximately two-thirds of slip-resistive aggregate over pavement surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
3. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
4. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.

D. Rock-Salt Finish: After initial floating, uniformly spread 5 lb/100 sq. ft. rock salt over pavement surface.

1. Cover pavement surface with 1-mil- thick polyethylene sheet and remove sheet when concrete has hardened and 7-day curing period has elapsed.
2. Embed rock salt into plastic concrete, power float concrete, and trowel finish.
3. After 7-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt.

E. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to pavement surface according to manufacturer's written instructions and as follows:

1. Uniformly spread dry-shake hardener at a rate of 100 lb/100 sq. ft., unless greater amount is recommended by manufacturer to match pavement color required.
2. Uniformly distribute approximately two-thirds of dry-shake hardener over pavement surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second dry-shake hardener application, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed by power floating.
3. After final floating, apply a hand-trowel finish followed by a broom finish to concrete.

4. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to 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.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moist 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.

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. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
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.

3.10 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/8 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/8 inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.

6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.11 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with City's Representative.

B. Allow concrete pavement to cure for 7 days and be dry before starting pavement marking.

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. Spread glass beads uniformly into wet pavement markings at a rate of 6 lb/gal..

3.12 FIRE HYDRANT MARKER INSTALLATION

A. Install markers to identify each new or relocated fire hydrant. Locate marker approximately 12 inches from the center stripe of a striped road, or 18 inches from the centerline of the travel lanes on a road without center striping, towards the side where the fire hydrant is located.

B. Affix marker to pavement using epoxy adhesive specifically intended for such use.

3.13 WHEEL STOPS

A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded in holes drilled or cast into wheel stops at one-quarter to one-third points. Firmly bond each dowel to wheel stop and to pavement. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least 1 composite sample for each 5000 sq. ft. or fraction thereof of each concrete mix 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 least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064; 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. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.

   a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mix will be satisfactory if average of any 3 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.

D. Test results shall be reported in writing to City's Representative, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting 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 both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by City's Representative but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting 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 City's Representative.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.15 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by City's Representative, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

3.16 CLEAN UP

A. Do not allow any concrete spill or waste on planting area.

B. Guard against graffiti; guarding shall be 24 hours a day if necessary. All marked, defective or defaced material shall be replaced by removing the entire section between construction joints.

C. Remove all concrete debris and spill from all planting areas, leaving the area clean and free of all noxious materials.

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SECTION 32 84 00

PLANTING IRRIGATION

PART 1 – GENERAL

1.1 SUMMARY:

A. Scope of Work: Provide all labor, materials, transportation and services necessary to furnish and install irrigation systems as shown on the Drawings and described herein.

B. Work Included: Provide irrigation system, complete, as shown and as specified.

1.2 RELATED SECTIONS:

A. Section 329000 Landscaping

1.3 QUALITY ASSURANCES:

A. Applicable Standards: Comply with the current applicable provisions of the following, with applicable codes and regulations of the locality and as specified.

1. "UPC" - Uniform Plumbing Code published by the Association of Western Plumbing Officials
2. "ASTM" - American Society for Testing and Materials
3. "AWWA" - American Water Works Association
4. "NSF" - National Sanitation Foundation
5. ”A.S.S.E.” and the USC Foundation for Cross Connection Control.

B. Permits and Fees: The Contractor shall obtain and pay for any and all permits and all inspections as required.

C. Manufacturer's Directions: Manufacturer's directions and detail drawings shall be followed in all cases where the manufacturer’s articles, equipment, materials or processes specified for use in this contract furnish such directions covering points not shown in the Drawings and Specifications.

D. Ordinances and Regulations: All 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 or higher standard than is required by the above rules and regulations, the provisions of these Specifications and Drawings shall take precedence.

E. Explanation of Drawings:

1. Due to the scale of Drawings, it is not possible to indicate all offsets, fittings, sleeves, etc. which may be required. The Contractor shall carefully investigate the structural and finished conditions affecting all of his work and plan his work accordingly, furnishing such fittings, etc. as may be required to meet such conditions. Drawings are generally diagrammatic and indicative of the work to be installed. The work shall be installed in such

a manner as to avoid conflicts between irrigation systems, underground utilities, planting and architectural features.

2. The term “Owner’s Representative” as used herein shall refer to the Owner's official authorized representative.
3. All work called for on the Drawings by notes or details shall be furnished and installed in compliance to the manufacturer’s instructions whether or not specifically mentioned in the Specifications.
4. The Contractor shall not willfully 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 engineering. Such obstructions or differences should be brought to the attention of the Owner's authorized representative. In the event this notification is not performed, the irrigation contractor shall assume full responsibility for any revision necessary.

1.4 SUBMITTALS:

A. Submit a list only of irrigation equipment to be used, within 30 days of notice to proceed. See irrigation schedules for equipment used.

<u>IRRIGATION EQUIPMENT MASTER LIST</u>

1. Plastic Pressure Pipe: Schedule 40 PVC

2. Plastic Non-pressure Pipe: Schedule 40 PVC, NO 1/2” PIPE SHALL BE USED,
3. Sub-surface Drip Tubing:
   a. ‘Rainbird’ XFS-06-12
   b. ‘Netafim’ TLEZ6-1203
   c. ‘Hunter’ HDL-06-12-XXX-PC

4. Drip Stakes, 11 gauge min.:
   a. ‘Rainbird’ XF series TDS-050
   b. ‘Netafim’ TLS6
   c. ‘Sandbaggy’ 11 gauge

5. Automatic Drip Tubing Flush Valve:
   a. ‘Rainbird’ MDCFCAP
   b. ‘Netafim’ TLFV-1
   c. ‘Hunter’ AVF

6. Air Vacuum Relief Valve for Drip System:
   a. ‘Rainbird’ ARV050
   b. ‘Netafim’ TLAVRV
   c. ‘Hunter’ PLD-AVR

7. Drip Operation Indicator:
   a. ‘Rainbird’ OPERIND
   b. ‘Netafim’ 10-F-01
   c. ‘Hunter’ ECO-ID

8. Plastic Pipe Fittings: Schedule 40 PVC

9. Plastic Nipples: Schedule 80 PVC

10. Swing Joints:
    a. Rainbird TSJ12
    b. LASCO
    c. ‘Hunter’ SJ-712 & SJ-512

11. Valve Manifold Fittings: ‘Dura’ manifold system, slip x swivel on both sides of valve

12. Metal Pipe Fittings: Red Brass IPS 125

13. Drip Remote Control Valve, Pressure Regulator, and Filter Assembly:
    a. ‘Rainbird’ XCZ
    b. ‘Irritrol’ 700DK-XX-LF
    c. ‘Hunter’ ICZ

14. Pressure Regulating Valve, Brass:
    a. ‘Zurn’
    b. ‘Wilkins’
    c. ‘Watts’

15. Gate Valves:
    a. ‘Nibco’ T-113K with brass hand wheel
    b. ‘Milwaukee’ bronze non-rising
    c. ‘Dixon’ BGV

16. Quick Coupler Valves: ‘Rainbird 44LRC’

17. Valve Boxes:
    a. ‘Carson’
    b. ‘Oldcastle’
    c. ‘Rainbird’

18. Controller: Existing ‘Toro’ Sentinel 48-station

19. Control Wire: In conduit color coded, twisted pair wire, 18 AWG

20. Wire Connectors:
    a. ‘Spears’ Dri-Splice waterproof, DBYR-6 with filler
    b. ‘3M’ DBR/Y Dryconn
    c. ‘Rainbird’ WC20

21. Valve I.D. Tags:
    a. ‘Christy’ Tags
    b. ‘GIDSTD’
    c. ‘Seton US’

22. PVC Primer/Solvent: ‘Weld-On’ P68/2711

23. Plumber’s Tape

24. Valve Box Supports: Concrete brick

25. Valve Box Aggregate: 3/8" pea gravel

26. Reduced Pressure Backflow Preventer: Existing

27. PVC Sleeve: Schedule 40 PVC, 2 times diameter of sleeved pipe, 2” diameter minimum

B. The Contractor shall furnish the articles, equipment, materials or processes specified by name in the Drawings and Specifications. No substitution will be allowed without prior written approval by the Owner’s Representative.

C. Complete material list shall be submitted prior to performing any work. Material list shall include the manufacturer, model number and description of all materials and equipment to be used. The following is a guide to proper submittal format:

Item	Description	Manufacturer	Model No.
Backflow preventer		FloCo	XXXX

D. Irrigation submittal must be specific and complete. All items must be listed and manufacturer's literature (catalog cuts) are required as submittal information, unless requested.

E. The Contractor may submit substitutions for equipment and materials listed on the irrigation drawings by following procedures as outlined in Section 1.6 of the Irrigation Specifications.

F. Equipment or materials installed or furnished without prior approval of the Owner’s Representative may be rejected and the Contractor required to remove such materials from the site at his/her own expense.

G. 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.

H. Manufacturer's warranties shall not relieve the Contractor of his/her liability under the guarantee. Such warranties shall only supplement the guarantee.

I. Record Drawings:

1. The Contractor shall provide and keep up-to-date a complete record set of job site prints which shall be corrected daily and show every change from the original Drawings and Specifications and the exact, in place locations, sizes, and kinds of equipment. Prints for this purpose may be obtained from the Owner’s Representative. This set of Drawings shall be kept on the site and shall be used only as a record set.
2. These Drawings shall also serve as work progress sheets and shall be the basis for measurement and payment for work completed. The Contractor shall make neat and legible annotations thereon daily as the work proceeds, showing the work as actually installed. These Drawings shall be available at all times for inspection and shall be kept in a location known to the Owner’s Representative.
3. The Contractor shall dimension from two permanent points of reference, building corners, sidewalk or road intersections, etc., the location of the following items:

a. P.O.C. Connection to existing water lines
b. P.O.C. Connection to existing electrical power
c. Control valves
d. Gate valves
e. Quick coupling valves
f. Routing of sprinkler pressure lines. (dimension maximum 100 feet along routing)
g. Routing of control wiring (dimension maximum 100 feet along routing)
h. All drip flush valves and air/vac relief
i. Other related equipment as directed by the Owner's Representative

4. Before the date of the final inspection, the Contractor shall deliver the record prints to the Owner's Representative. All work shall be neat, in ink and subject to the approval of the Owner's Representative. The Owner's Representative will transfer the Contractor's record information onto the digital files and will return the record drawings and provide the Contractor with a reduced print for the Contractor's use in preparing controller chart(s).

J. Controller Charts:

5. The charts shall be a reduced Xerox bond print of the digital record drawing and the contractor shall use different colors to indicate the zones of coverage for each controller station, including existing stations to remain.
6. When completed the Contractor shall seal the charts between two pieces of plastic, each piece being a minimum of 10 mils in thickness.
7. Provide two controller charts for each controller, one for the controller enclosure and one for the Owner.
8. These charts shall be completed by the Contractor and approved by the Owner's Representative prior to final inspection of the irrigation system.

K. Operation and Maintenance Manuals:

9. Prepare and deliver to the Owner's Representative within ten calendar days prior to completion of construction, two hard cover, three ring binders containing the following information:

   a. Index sheet stating Contractor's address and telephone number, list of equipment with name and addresses of local manufacturer's representatives.
   b. Guarantee statement.
   c. Catalog and parts sheets on every material and equipment installed under this contract.
   d. Complete operating and maintenance instruction on all major equipment. This shall include maintenance information published by the manufacturer.

10. 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 Owner's Representative at the conclusion of the project that this service has been rendered.

L. Equipment to be Furnished:

1. Supply as part of this contract the following tools:

   a. Two valve keys for operation of remote control valves
   b. Two keys for automatic controller and enclosure

c. One key for every (3) quick coupler installed
d. Extra remote control valves. Supply one valve for each size used

2. The above mentioned 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 the Owner's Representative.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING OF PVC PIPE AND FITTINGS:
1.6 ND FITTINGS:

A. The Contractor is cautioned to exercise care in handling, loading, unloading and storing of PVC pipe and fittings.

B. Store PVC pipe and fittings under cover until used. Do not leave pipe and fittings in open trenches, exposed to sunlight for extended periods.

C. 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.

D. Any section of pipe that has been dented or damaged will be discarded and, if installed, shall be replaced with new piping.

1.6 SEQUENCING AND SCHEDULING:

A. Install landscape headers, sidewalks, and mowing strips before installation of sprinkler system, except that sleeves and mainlines under paving shall be in place before paving construction.
B. Specimen trees (48 inch box and larger) shall be installed after staking but before the installation of the irrigation system.
C. Obtain permission in writing from the Owner at least 24 hours before shutting off existing in-use water lines. The Contractor shall receive instructions from the Owner as to the exact length of time of each shut-off.

1.7 SUBSTITUTIONS:

A. If the irrigation contractor wishes to substitute any equipment or materials for that which is listed on the irrigation Drawings and Specifications, they may request to do so by providing the following information to the Owner's authorized representative for review:

1. Provide a statement indicating the reason for making the substitution. Use a separate sheet of paper for each item to be substituted.
2. Provide descriptive catalog literature, performance charts and flow charts for each item to be substituted.
3. Provide the amount of cost difference if the substituted item is approved.

B. The Owner's authorized representative shall have the sole authority and responsibility of accepting or rejecting any substituted item as an approved equal to those equipment and materials listed on the irrigation Drawings and Specifications.

1.8 GUARANTEE:

A. The guarantee for the sprinkler irrigation system shall be made in accordance with the attached form at the end of this section. The general conditions and supplementary conditions of these

Specifications shall be filed with the Owner or his representative prior to acceptance of the irrigation system.

B. A copy of the guarantee form shall be included in the Operations and Maintenance Manual.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. General: Use only new materials of brands and types noted on Drawings, specified herein or approved equals.

B. The design of the irrigation system is based on the manufacturers and products indicated. Substitutions will be permitted only with the Owner's Representative approval. Where such substitution will change the coverage or flow rates of the sprinkler heads, or velocity and friction loss in pipe, the request for substitution shall include layout plans showing revised sprinkler head locations. Such revised layout plan shall provide coverage and watering rates equivalent to those indicated.

C. PVC Pressure Mainline Pipe: Pipe sizes indicated are nominal inside diameter unless otherwise noted.

1. Pressure mainline piping for sizes 1-1/2 inches and smaller shall be PVC Schedule 40 with solvent-welded joints, white color. Pipe shall be made from NSF approved Type I, Grade I PVC compound conforming to ASTM Resin Specification D1784 and product design specification ASTM 1785. All pipe must meet requirements as set forth in Federal Specification PS-21-70 (solvent-weld pipe).
2. Pressure mainline piping for sizes 2 inches and larger, shall be PVC Class 315 (S.D.R. 13.5) with solvent-weld joints, white color. Pipe shall be made from an NSF approved Type I, Grade I, PVC compound conforming to ASTM resin specification D1784 and product design specification ASTM 2241. All pipe must meet requirements as set forth in Federal Specification PS-22-70, with an appropriate standard dimension (S.D.R.) (solvent- weld pipe).
3. All PVC pipe must bear the following markings:
   a. Manufacturer's name
   b. Nominal pipe size
   c. Schedule or class
   d. Pressure rating in PSI
   e. NSF (National Sanitation Foundation) approval
   f. Date of extrusion

D. PVC Non-Pressure Lateral Line Piping: Pipe sizes indicated are nominal inside diameter unless otherwise noted.

1. Non-pressure buried lateral line piping of all sizes (3/4" minimum) shall be PVC Schedule 40 (S.D.R. 21) with solvent-weld joints, white color.
2. Pipe shall be made from NSF approved, Type I, Grade I PVC compound conforming to ASTM Resin Specification D1784. All pipe must meet requirements set forth in Federal Specification PS-22-70 with an appropriate standard dimension ratio.

3. Except as noted in paragraph 1 and 2 of Section 2.1.C, all requirements for non-pressure lateral line pipe and fittings shall be the same as for solvent-weld pressure mainline pipe and fittings as set forth in Section 2.1.B of these Specifications.

E. PVC Solvent-Weld Fittings and Connections:

1. For pressure lines 3” and smaller upstream of remote control valves, hose bibs and quick couplers. ASTM D 2467, Type 1, Grade 1, Schedule 80, impact molded fittings, manufactured from virgin compounds as specified for piping, tapered socket or molded thread type, suitable for either solvent weld or screwed connections. Machine threaded fittings and plastic saddle and flange fittings are not acceptable.
2. For non-pressure lines downstream of remote control valves. ASTM D 2464 or D 2466, Type 1, Grade 1, Schedule 40, high impact molded fittings, manufactured from virgin compounds as specified for piping, tapered socket or molded thread type, suitable for either solvent weld or screwed connections. Machine threaded fittings and plastic saddle and flange fittings are not acceptable.
3. All fittings shall bear the manufacturer's name or trademark, material designation, size, applicable I.P.S. schedule and NSF seal of approval.

F. PVC Welding Solvent and Primer:

1. Solvent cements shall comply with ASTM D2564. Socket joints shall be made per recommended procedures for joining PVC plastic pipe and fittings with PVC solvent cement and primer by the pipe and fitting manufacturer and procedures outlined in the appendix of ASTM D2564.
2. All Classes PVC:
   a. 2 " and under - Weld-On 2721 or 2711 PVC Solvent and P-70 Primer
   b. 3” and over - Weld-On 2711 PVC Solvent and P-70 Primer
3. Schedule 40 PVC:
   a. 2 " and under -Weld-On 2721 or 2711 PVC Solvent and P-70 Primer
   b. 3” and over - Weld-On 2711 PVC Solvent and P-70 Primer
4. Schedule 80 PVC
   a. All sizes - Weld-On 2711 PVC Solvent and P-70 Primer.

G. PVC to PVC or PVC to Metal Threaded Connections:

1. Thread lubricant shall be teflon ribbon-type, suitable for threaded installations as per PVC pipe and fitting manufacturer's recommendations.

H. PVC Schedule 80 Risers and Nipples:

1. Polyvinyl Chloride Schedule 80 Risers and Nipples. Type 1, Grade 1, Schedule 80, high impact molded, manufactured from virgin compounds as specified for piping. Threaded ends shall be molded threads only. Machined threads are not acceptable. PVC Schedule 80 nipples and risers shall conform to ASTM D-2464.

I. Brass Pipe and Fittings:

1. Where indicated on the Drawings, IPS, 125 pound, 85% red brass screwed pipe conforming to ASTM B 43-91.
2. Fittings shall be IPS, 125 pound, 85% red brass, threaded, conforming to ANSI B16.15-85.

J. Control Wiring:

1. Connections between the automatic controller and the electric control valves shall be made with direct burial copper wire AWG-U.F. 600 volt. Pilot or station wire shall be 14 gauge, common wire 12 gauge.
2. Connections between the flow sensor and the controller shall be made with Arizona Electric, AEF#9516-2SP 2-conductor shielded cable in 1-1/4" conduit .

K. Control Wiring Water Proof Connectors:

1. Field splices between the automatic controller and electrical control valves shall not be allowed without prior approval of the Owner's Representative
2. All splices of control wiring shall be made with Spears Dri-Splice, Rainbird Snap-Tite wire connector or approved equal.

L. Pull Boxes:

1. Pull boxes for control wire shall be Carson No. 1419-12 with dimensions of 10-3/4" x 16" x 12", or approved equal. Boxes shall be green in color with green covers. The cover shall be secured with a stainless steel bolt-down mechanism. Pull box extensions shall be by the same manufacturer as pull box.

2. The cover shall be heat branded with the letters IRR-COM two inches high. Pull Boxes shall not exceed 500' in distance apart and be located at every street or driveway crossing.

M. Remote Control Valve and Remote Control Valve / Pressure Regulator Assembly:

1. Remote control valve shall be normally closed electrically actuated diaphragm type. Valve body shall be constructed of brass and stainless steel. Valve shall include manual flow adjustment handle and internal manual bleed cock for manual operation. Valve shall be as specified in the irrigation materials legend.
2. The remote control valve shall include a tag to identify the Controller / Station number. Controller / Station ID tags shall be maxi size, as manufactured by Christy's Irrigation or approved equal.

N. Isolation Valves:

1. Isolation valves with key shall be as specified in the irrigation legend.

O. Quick Coupling Valves:

1. Quick coupling valve with key shall be as specified in the irrigation legend.

P. Control Valve Boxes:

1. Use 10" diameter round box for all gate valves and quick couplers. Carson Industries No. 910-12 with bolt down cover, green color, or approved equal. Valve box extensions shall be by the same manufacturer as the valve box.
2. Use 11-7/8 inch x 17 inch x 12 inch rectangular box for each remote control valve/pressure regulator assembly and filter assembly. Box shall be Carson Industries No. 1419-12 with bolt down cover, green color, or approved equal.

Q. Drip System:

1. Shall be a complete system of in-line emitter drip line, fittings, vacuum/air release valves, flush valves, and system operation indicators equal to that manufactured by Rainbird:

    a. XFS SERIES Subsurface Dripline with CopperShield Technology with emitter size and spacing per plan
    b. QF Dripline header
    c. Air Vent Assembly per plan
    d. Required Inlet/Outlet Fittings
    e. Flush Assembly Fittings
    f. Installation Fittings
    g. Insert fitting tees, couplings, elbows and end clamps for a secure connection
    h. Soil staples for secure tubing placement during installation
    i. Operation indicator per plan

R. Sleeves shall be schedule 80 PVC under roads and schedule 40 PVC under walks. Sleeve sizes shall be two (2) times the diameter of the sleeved pipe, with a 2" minimum diameter as manufactured by Pacific Western Pipe or approved equal.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Site Conditions:

1. Before start of installation of the irrigation system, examine the site, construction documents and/or as-built drawings of other trades to:
    a. Verify location of existing underground utilities valves, manholes, catch basins, and other appurtenances that will affect the layout of the sprinkler system.
    b. Verify location of existing trees, new trees, and other obstructions that will affect the layout of the sprinkler system.
    c. Verify location of stub outs and points of connection to the water supply system.
    d. Verify grades to determine that work may safely proceed in keeping within the specified trench depths.

B. Exercise extreme care in excavating and working near existing utilities. The contractor shall be responsible for damages to utilities which are caused by his operations or neglect. Check any existing utility drawings for existing utility locations.

3.2 PREPARATION:

A. Physical Layout:

1. Locations indicated are diagrammatic and approximate only and shall be changed and adjusted as necessary and as directed to meet existing and built conditions and to obtain complete water coverage.
2. Prior to installation, the Contractor shall stake out all pressure supply lines and control wire routing, control valve and sprinkler head locations. Maintain the staking of the approved layout until installation is completed.
3. All layouts shall be approved by the Owner's Representative prior to installation.

4. Exercise extreme care in excavating and working near existing utilities. Contractor shall be responsible for damages to utilities which are caused by their operations or neglect. Refer to civil drawings for existing utility locations.
5. Sprinkler lines shall have a minimum clearance of 3 inches from each other and 36" from other utility lines. Do not install parallel lines directly over one another.
6. Coordinate installation of irrigation materials, including pipe, so there shall be NO interference with utilities or other construction or difficulty in planting trees, shrubs and groundcovers.

B. Water Supply:

1. The irrigation system shall be connected to water supply points of connection as indicated on the drawings and as approved by the owner.
2. Connections shall be made at approximate locations as shown on the Drawings. (See also civil drawings).
3. The contractor is responsible for minor changes caused by actual site conditions.

C. Electrical Supply:

1. Electrical power supply connection is available at an existing automatic controller and is located approximately where shown on the Drawings. The contractor shall have a licensed electrician connect the existing power supply to the new controller and shall verify the continuity of the electrical supply prior to beginning their work.

3.3 EXCAVATING AND TRENCHING:

A. General: Perform all excavations as required for installation of work, including shoring of earth banks, if necessary.

B. Trenching:

1. Dig trenches straight and support pipe continuously on bottom of trench. Lay pipe to an even grade. Trenching excavation shall follow layout indicated on drawings and as noted.
2. Trench depth shall be adequate to provide backfill cover to a depth measured from top of pipe to finished grade as follows:

   a. Provide for a minimum cover of 18 inches for all PVC pressure mainlines 2" and smaller.
   b. Provide for a minimum cover of 12 inches for all PVC non-pressure lines 1-1/2" and smaller.
   c. When trench is shared with PVC pressure mainline, provide for a minimum cover of 18 inches for all control wiring.

C. Backfilling:

1. The trenches shall not be backfilled until all required tests are performed (see section 3.6). Trenches shall be carefully backfilled with the excavated materials approved for backfilling. Backfilled trenches in landscaped areas shall be mechanically compacted in to a dry density equal to adjacent undisturbed soil. Backfilled areas will conform to adjacent grades without dips, sunken areas, humps or other surface irregularities.
2. Excavated trench material used for backfill shall consist of earth, loam, sandy clay, sand or other approved materials, free from large clods of earth or stone. Approved backfill shall

be a fine granular material without foreign matter, rocks, clods or stones larger than 1/2 inch in size.

3. Where existing on-site material is not suitable as backfill, the contractor shall provide sand bedding a minimum of 2 inches under, around and 2 inches above top of pipe for PVC plastic pipe and brass piping.
4. Flooding of trenches will be permitted only with approval of the Owner's Representative.
5. If settlement of any backfilled area occurs and subsequent adjustments and/or repairs of pipe, valves, sprinkler heads, lawn or planting or other construction are necessary, the Contractor shall make all required adjustments and/or repairs without additional cost to the Owner.

D. Trenching and Backfilling Under Paving:

1. Trenches located under areas where paving, asphaltic concrete or concrete will be installed shall be backfilled with sand (a layer 4 inches below the pipe and 3 inches above the pipe) and compacted in layers to 95% compaction, using manual or mechanical tamping devices. Trenches for piping shall be compacted to equal the compaction of the existing adjacent undisturbed soil and left in a firm unyielding condition. All trenches shall be left flush with the adjoining grade. The landscape irrigation 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 Owner's Representative. No hydraulic driving will be permitted under concrete paving. Compact all backfill to 95% dry density and dispose of waste off site. Replacement pavement shall match existing in structure, material and appearance.
3. Provide for a minimum cover as listed in section 3.3-B 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.

E. Point of Connection (POC):

1. Connections to Water Supply: Connect new underground piping to existing water supply line downstream from the backflow preventer shut-off. Provide flanges, adapters and other necessary fittings required to make the connections.

F. Installation of PVC Pipe:

1. Pipe shall be cut using approved PVC pipe cutters only. Sawed joints will not be permitted. All field cuts shall be beveled to remove burrs and excess before fitting and solvent weld of joints.
2. PVC Pipe and fittings shall be thoroughly cleaned of dirt, dust and moisture before joints are made. Pipe ends and fittings shall be treated with MEK, or other primer recommended by the pipe manufacturer, before welding solvent is applied.
3. Socket joints shall be made in accordance with recommended procedures for joining PVC plastic pipe and fittings with PVC solvent cement by the pipe and fitting manufacturer and procedures outlined in the Appendix of ASTM D 2564-93. Welded joints shall be given a minimum of 15 minutes to set before moving or handling. Install no assembly into a trench which has standing water.

4. When connection is plastic to metal, PVC female adapters shall be used with short (not close) PVC SCH 80 threaded nipples if needed to complete the connection. Joints shall be made with 2 clockwise wraps of Teflon tape on male threaded fitting. Hand tightened joint plus one turn with a strap wrench.

5. Assemble and place pipe lines having rubber ring seal joints in accordance with manufacturer's written instructions.
6. Snake pipe from side-to-side of trench bottom to allow for expansion and contraction.
7. No water shall be permitted in the pipe until inspections have been completed and a period of at least 24 hours has elapsed for solvent weld setting and curing.
8. Center load pipe with approved backfill to prevent arching and slipping under pressure. Leave joints exposed for inspection during testing.
9. At changes of direction of 45 degrees or more for pipes 2-1/2 inches and larger, construct concrete thrust blocks against undisturbed earth with sufficient bearing to resist the thrust of water.

G. Conduit and Sleeves:

1. Coordination: Provide materials and coordinate installation with other trades as required to facilitate a smooth construction sequence.
2. Conduit: Furnish and install conduit where control wires pass under or through walls, walks and paving. Conduits to be of adequate size to accommodate retrieval for repair of wiring and shall extend 12 inches beyond edges of walls and pavement. Use conduit sweeps at all changes in direction.
3. Sleeving: Install sleeves for all pipes passing through or under walks and paving as shown on the Drawings. Sleeving to be of adequate size to accommodate retrieval of wiring or piping for repair and shall extend 12 inches beyond edges of paving or other construction. Curve sleeves where required by heat forming pipe. No fittings shall be used for sleeves.

H. Assemblies:

1. Routing of irrigation lines as indicated on the drawings is diagrammatic. Install lines (and various assemblies) in such a manner as to avoid conflicts with other improvements and to route within planting areas in accordance with the details and plans. See planting plans for tree locations to avoid aligning irrigation under tree rootballs.
2. Install all assemblies specified herein in accordance with respective detail drawings. In absence of detail drawings or specifications pertaining to specific items required to complete work, perform such work in accordance with manufacturer direction, best standard practice and approval of Owner’s Representative.
3. 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. Install no assembly into a trench which has standing water.
4. On PVC to metal connections, the Contractor shall work the metal connections first. Teflon tape or approved equal shall be used on all threaded PVC to PVC 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. Use strap-type friction wrench only - no metal jawed wrench.

I. Line Clearance: All lines shall have a minimum clearance of 6 inches from each other and from lines of other trades. Parallel lines shall not be installed directly over one another.

J. Control Wire:

1. Provide one control wire and one common ground wire to service each valve in system or per plan notes. Provide 4 foot minimum expansion loop at each valve to permit removal and maintenance of valves.
2. Wiring shall occupy the same trench and shall be installed along the same route as pressure supply or lateral lines wherever possible.
3. Install control wires at least 16 inches below finish grade and minimum of 4 inches from pipe or fittings except at terminal points.
4. Where more than one wire pair is placed in a trench, the wiring shall be bundled and taped together at intervals of 10 feet, using two wraps of electrical tape.
5. An expansion curl shall be provided at each major change of direction and at every remote control valve. Expansion curl (or coil) at the remote control valve shall be 4 feet long. Control wires shall be laid loosely in trench without stress or stretching of control wire conductors.

K. Water Proof Wire Connectors for Control Wire:

1. All splices shall be made according to the manufacturer's directions.

L. Pull Boxes:

1. Pull boxes for control wire shall be installed at ends of sleeves for paving crossing in excess of 50'.

M. Remote Control Valves:

1. Install remote control valves in locations approximately as shown on the drawings.

2. Brand corresponding valve numbers into lid of valve box using electric iron.

3. For drip/low volume valve manifold assemblies, each manifold shall have a separate ball valve, filter, preset pressure regulator and remote control valve.

N. Isolation Valves:

1. Install each gate valve as detailed and noted in a separate valve box with extension as needed to provide access. See also location requirements as described for remote control valves. Install all ball valves, globe valves and gate valves approximately where shown on drawings and per the detail drawings. Do not locate in paving.

O. Quick Coupling Valves:

1. Install each quick coupler valve as detailed and noted within a separate valve box. See also location requirements as described for remote control valves.

P. Subsurface Drip Irrigation Installation:

1. Excavate amended soil in all areas to be drip irrigated to 4" depth below finish grade for drip lines, per the detail drawings.
2. Install PVC pipe manifolds in trenches and through sleeves under paving per plan and the detail drawings. Connect to drip valve assembly.
3. Lay tubing on grade, cut and staple according to spacing indicated on the detail drawings.

4. Connect tubing with required fittings, air/vacuum relief valves, flush valves and operation indicators.

Q. Flushing of System:

1. Cap or plug all openings as soon as lines have been installed to prevent the entrance of debris or any contaminants that will obstruct pipe line or foul small orifice emitters. Leave in place until connections can be completed.
2. After all irrigation system valves, pipes and risers are in place and before connection of lateral lines, the control valves shall be opened and a full head of water used to flush out the system.
3. Sprinkler heads shall be installed only after flushing of the entire system, including lateral lines and swing joints, has been accomplished to the complete satisfaction of the Owner's Representative.
4. Line flush valves shall be installed only after flushing of the system has been accomplished to the complete satisfaction of the Owner's Representative.

3.4 TECHNICAL SUPPORT:

A. The Contractor shall schedule and conduct an on-site pre-construction system familiarization meeting for Contractor, Owner's Representatives to insure that all parties involved understand the system and installation techniques.

3.5 TEMPORARY REPAIRS:

A. The Owner reserves the right to make temporary repairs as necessary to keep the existing sprinkler system equipment in operating condition. The exercise of this right by the builder/developer shall not relieve the Contractor of his/her responsibilities under the terms of the guarantee as herein specified.

3.6 FIELD QUALITY CONTROL:

A. Adjustment of the System:
1. If it is determined that adjustments in the irrigation equipment will provide better uniformity of coverage, the Contractor shall make such adjustments prior to planting.
2. Lowering and raising valve boxes or any other adjustments by the Contractor shall be accomplished within ten days after notification by Owner.

B. Testing of Irrigation System:

1. The Contractor shall request the presence of the Owner's Representative in writing at least 48 hours in advance of testing.
2. Test all pressure lines under hydrostatic pressure of 150 pounds per square inch and prove watertight. Note: Testing of pressure mainlines shall occur prior to installation of electric control valves.
3. All piping under paved areas or on structure shall be tested under hydrostatic pressure of 150 pounds per square inch and proved watertight.
4. Sustain pressure in lines for not less than two hours with 5 psi maximum drop in pressure. If leaks develop, replace joints and repeat test until entire system is proven watertight.
5. All hydrostatic tests shall be made only in the presence of the Owner's Representative or other duly authorized representative of the Owner. Center load pipe sections between

fitting with backfill to prevent arching during hydrostatic testing. All fittings are to be left exposed.

6. Backfill of pipe trenches cannot be completed until pipes have been inspected, tested and approved by the Owner's Representative.
7. Furnish necessary force pump and all other test equipment.
8. Furnish all materials and perform all work required to correct any inadequacies of coverage.

3.7 MAINTENANCE:

A. The entire irrigation system shall be under full automatic operation prior to any shrub and groundcover planting. Trees shall be watered by hand until the irrigation system is operable.

B. Final acceptance of the planting by the Owner's Representative shall constitute the beginning of the guarantee period and the 90-day irrigation maintenance and plant establishment period.

3.8 CLEAN-UP:

A. Clean-up shall be made as each portion of work progresses. Refuse and excess dirt shall be removed from the site, all walks and paving shall be swept or washed down and any damage sustained on the work of others shall be repaired to original condition.

3.9 FINAL INSPECTION PRIOR TO ACCEPTANCE:

A. The Contractor shall operate each system in its entirety for the Owner's Representative at time of final inspection. Any items deemed not acceptable by the inspector and/or Owner's Representative shall be reworked to the complete satisfaction of the Owner's Representative.

B. The Contractor shall show evidence to the Owner's Representative that the Owner has received all maintenance manuals, documentation of testing, irrigation accessories, charts, record drawings and equipment as required before final inspection can occur.

3.10 OBSERVATION SCHEDULE:

C. Contractor shall be responsible for notifying the Owner's Representative in advance for the following observations, according to the notice time indicated:

a. Pre-job conference - 7 days in advance
b. Pressure supply line installation and testing, control wire installation - 48 hours in advance
c. Coverage test and final observation - 48 hours in advance

D. When observations have been conducted by other than the Owner's Representative, show evidence of when and by whom these observations were made.

E. No observation will commence without the record drawings. In the event the Contractor calls for an observation without record drawings, without completing previously noted corrections or without preparing the system for observation, they shall be responsible for reimbursing the Owner's Representative at the hourly rate of $100.00 for the inconvenience. No further observations will be scheduled until this charge has been paid.

3.11 PROJECT CLOSE OUT:

A. The Landscape Architect, the Owner's representative and the Contractor will utilize the following checklist as the work progresses.

B. Each item represents a milestone in the execution of the work and must be initialed by the Landscape Architect or the Owner's representative as being complete prior to acceptance of the work by the Owner.

IRRIGATION SYSTEM CHECKLIST

	Item	Date	Initial
1.	Irrigation Equipment Submittal		
2.	Submit manufacturer's brochures, maintenance manuals, warrantees and operating instructions		
3.	Mainline Test / Valve Inspection		
4.	Complete System Test		
5.	Final Coverage Test		
6.	Record Drawings		
7.	Controller Charts/Schedule		
8.	Equipment Use Instruction		

9. The Contractor guarantees a complete water irrigation system for a period of one (1) year from the date of final acceptance. Guarantee includes non-settling of the backfill in trenches and excavations, which if occurs, shall be corrected by the Contractor at no additional expense to the owner, including repairs and/or replacement of any material damaged thereby or therefrom.

Contractor _____

Signature _____ Date _____

END OF SECTION 32 84 00

SECTION 32 90 00

LANDSCAPING

PART 1 – GENERAL

1.1 SUMMARY:

A. The work includes all services, labor, materials, transportation and equipment necessary to perform the work as shown and noted on the drawings and/or specified herein.

B. All utilities (water and electricity) used during the installation of the landscaping and irrigation systems for this project shall be paid for by the Owner.

C. All plant material will be purchased by the Contractor and delivered to the site by the Contractor's supplier for off-loading and installation by the Contractor.

D. All planting areas shall be continuously maintained by the Contractor over the course of the Plant Establishment and Maintenance Period.

1.2 RELATED SECTIONS:

A. Section 32 05 10 Imported Soil and Rock

B. Section 32 84 00 Irrigation

C. Section 32 91 13 Soil Preparation

D. Section 01 97 39 Tree Protection

1.3 SUBMITTALS:

A. Contractor shall submit a complete list of soil amendments, fertilizers, and plant materials, specified with quantities and suppliers of each, a minimum of six (6) weeks prior to delivery to the site.

B. Contractor shall submit signed copies of certificates, invoices and trip slips to the Owner's Representative for verification of quantities of all materials delivered to site for incorporation into work.

C. Contractor shall submit one pint each of the following to the Owner's Representative for approval:

1. Soil Conditioner
2. Organic Mulch

1.4 GUARANTEES AND REPLACEMENTS:

A. All commercially grown shrubs, vines and groundcovers shall be guaranteed by the Contractor to remain healthy and vigorously growing for 90 days from date of final acceptance of project.

B. All trees that have been installed under this Contract shall be guaranteed by the Contractor to live in a healthy condition for a period of one (1) year from date of final acceptance of project.

C. All commercially grown plants found to be dead and all plants not in a vigorous condition noted within the Guarantee Period shall be replaced within (14) calendar days.

1.5 SITE OBSERVATION VISITS:

A. Site observation visits herein specified shall be made by the Owner's Representative. The Contractor shall request site observation two (2) days in advance of the time observation is required.

B. Site observation will be required for the following parts of the work:

1. Incorporation of soil conditioner and fertilizer into the soil and upon completion of grading prior to planting.
2. Approval of plant materials with trees and shrubs spotted in place for planting, but before planting holes are excavated.
3. When planting, and all other indicated or specified work, except the Plant Establishment Period, has been completed. Acceptance and written approval shall establish the beginning of the Plant Establishment Period.
4. Final site observation visit at the completion of the Plant Establishment Period. This site observation visit shall establish the beginning date for the guarantee period for plant material and irrigation.

C. Other site inspections will be made by the Owner's Representative at their discretion.

D. The Contractor or their authorized representative shall be on the site at the time of each scheduled site observation visit by the Owner's Representative.

1.6 MAINTENANCE:

A. The Contractor shall continuously maintain all involved areas of the Contract during the progress of the work and during a 90-day Plant Establishment and Maintenance Period until Final Acceptance of the work by the Owner's Representative.

B. Regular planting maintenance operations shall begin immediately after each plant is planted. Plants shall be kept in a healthy, growing condition and in a visually pleasing appearance by watering, pruning, trimming, edging, fertilizing, re-staking, pest and disease controlling, spraying, weeding, cleaning-up and any other necessary operation of maintenance. Landscape areas shall be kept free of weeds, noxious grass, and all other undesired vegetative growth and debris. All plants found to be dead or in an impaired condition shall be replaced in kind immediately.

C. No pruning of tree limbs shall be permitted without the consent of the Owner's Representative.

D. The Contract completion date of the Plant Establishment/Maintenance Period will be extended, when in the opinion of the Owner's Representative, improper maintenance and/or possible poor or unhealthy condition of planted material is evident. The Contractor shall be responsible for additional maintenance of the work at no change in Contract price until all of the work is completed and acceptable.

E. The Contractor shall be responsible for maintaining reasonable protection of contract areas. Damaged areas shall be repaired immediately at the Contractor's expense.

1.7 GENERAL REQUIREMENTS:

A. The term "Planting Area" shall mean all areas to be planted with trees, shrubs, groundcovers, lawn and vines.

B. Actual planting shall be performed during those periods when weather and soil conditions are suitable in accordance with locally accepted horticultural practice.

C. All rock and other growth or debris accumulated within the duration of the project shall be removed from the site.

D. Prior to excavation for planting or placing of plant materials, locate all underground utility lines still in use and take proper precautions to avoid damage to such improvements. In the event of a conflict between such lines and plant locations, immediately notify the Owner's Representative who shall arrange for the re-location of one or the other. The Contractor assumes all responsibility for making any and all repairs for damages resulting from work as herein specified.

E. Grading and soil preparation work shall be performed only during the period when beneficial and optimum results may be obtained. If the moisture content of the soil should reach such a level that working it would destroy soil structure, spreading and grading operations shall be suspended until the moisture content is increased or reduced to acceptable levels and the desired results are likely to be obtained.

F. All scaled dimensions are approximate. Before proceeding with any work, carefully check and verify all dimensions and immediately inform the Owner's Representative of any discrepancy between the drawings and/or specifications and actual conditions.

G. Quantities for plant materials are shown for convenience only, and not guaranteed. Check and verify count and supply sufficient number to fulfill intent of drawings. Certify any clarifications with the Owner's Representative.

H. Adequately stake, barricade, and protect all irrigation equipment, existing trees, manholes, utility lines, and other existing property during all phases of the soil amending planting and grading operations.

I. Upon completion of all grading operations, the Contractor shall request a Soil Sampling Kit from the Owner's Representative and then shall take a composite soil sample from representative planting areas throughout the site per Section 32 91 13

1.8 PLANT SELECTION:

A. Upon award of the project the Contractor shall inform the Owner's Representative of the nursery source of all plants. The Owner's Representative and the Owner will check the plants at the nursery source for approval. If the plants are rejected, the Contractor shall be responsible for locating other sources of plants. The contract price for the project shall not change due to rejected plants. The Contractor shall make all necessary financial arrangements or purchase orders to reserve the plants specifically for this project.

1.9 REJECTION AND SUBSTITUTION:

A. All plants not conforming to the requirements herein specified and on the drawings shall be considered defective and such plants, whether in place or not, shall be marked as rejected and be immediately removed from the site of the work and replaced with acceptable plant materials.

The plant materials shall meet all applicable inspections required by law. All plants shall be of the species, variety, size, age, flower color and condition as specified herein and/or as indicated on the drawings. Under no condition will there be any substitution of plant species, variety, or reduced sizes for those listed on the accompanying drawings, except with the express written consent of the Owner's Representative and the Owner.

1.10 INVOICING OF PLANT MATERIALS:

A. After installation of plant amendments and prior to the pre maintenance site observation visit, the Contractor shall provide the Owner's Representative with copies of the required certifications, trip slips, and invoices for the plant materials amendments and shall compare the total area and/or the amounts specified. If the minimum amounts have not been furnished, the Owner's Representative will require at the contractors expense, the installation of additional materials to fulfill the minimum requirements specified.

PART 2 - PRODUCTS

2.1 SOIL AMENDMENT AND FERTILIZER:

A. Soil amendments shall be added per the recommendation of the soil testing agency per Section 32 91 13

2.2 STAKING MATERIALS:

A. Double Staking: Stakes shall be of lodgepole pine. These shall be straight shafts, shaved and cut clean and bare of branches and stubs, of uniform thickness with a minimum diameter of 2 inches, free of loose knots, splits or bends. Stakes shall be no less than ten (10) feet in length.

B. Tree ties shall be V.I.T. Cinch-Tie or approved equal.

2.3 PLANT MATERIALS:

A. Nomenclature: The scientific and common names of plants herein specified conform with the approved names given in "A Checklist of Woody Ornamental Plants of California", published by the University of California, College of Agriculture, Publication 4091 (1979). See list of plant material on drawings.

B. Container stock (1 gallon, 5 gallon, 15 gallon and boxes) shall have grown in containers for at least six months, but not over two years. No container plants that have cracked or broken balls of earth, when taken from the container, shall be planted, except upon special approval. No trees with damaged roots or broken balls shall be planted.

C. Pruning shall not be done, prior to delivery, except by written approval by the Owner's Representative.

D. Inspection of Plant Materials, required by City, County or State authorities, shall be a responsibility of the Contractor, and where necessary the Contractor shall secure permits or certifications prior to delivery of plants to site.

E. Plants shall be subject to approval or rejection, at the project site at any time before or during progress of work, for size, variety, condition, latent defects and injuries. Rejected plants shall be removed from the project site immediately.

F. Substitutions will not be permitted unless proof is submitted by the Contractor that any plant specified is not obtainable. A proposal for substitution will be submitted by the Contractor to the Owner's Representative and the Owner for approval.

G. Quantities shall be furnished as needed to complete work shown on drawings.

H. The Owner's Representative reserves the right to check root condition of any species, particularly those grown from seed, and if found defective, to reject the plants represented by the defective sample.

I. Identify plant species or varieties correctly on legible, weatherproof labels attached securely to the plant material. There shall be a minimum of one labeled plant for each 25 plants in a lot.

J. Groundcover plants shall be healthy vigorous rooted cuttings grown in flats until transplanting.

2.4 MULCH:

A. Organic mulch shall be equal to
1. 'Agriservice' "Forest Fines" (760) 439-9920
2. 'Viramontes Soil'
3. 'California Soil Products'

2.5 HERBICIDES

A. No herbicides shall be used without the express written consent of the owner.

2.6 ROOT CONTROL BARRIERS

A. Provide sheet-type root barriers wherever paving comes within 10 feet of a tree. Root barriers shall be 24" high, one piece, void of hinge-type sections and with connections made by solvent-welded couplings. Material shall be a minimum of 0.60" thick with ½" vertical ribs at 6" on center and be made of at least 50% post-consumer high-impact polystyrene with rubberizer and UV inhibitors. Equal to: 'NDS' Root Barrier Sheet Material SM-2420. (800) 726-1994

PART 3 - EXECUTION

3.1 GENERAL

1. Amend existing site soils and container plant backfill per Section 32 91 13

3.3 FINISH GRADING:

A. Finish grades shall be as indicated on the landscape drawings.

B. Finish grades shall be measured as the final water compacted and settled surface grades and shall be within plus or minus 0.1 foot of the spot elevations and grade lines indicated on the drawings.

C. Finish grades shall be measured at the top surface of surface materials.

D. Molding and rounding of the grades shall be provided at all changes in slope and as directed by the Owner's Representative.

E. All undulations and irregularities in the planting surfaces resulting from tillage, rototilling and all other operations shall be leveled and floated out before planting operations are initiated.

F. The Contractor shall take every precaution to protect and avoid damage to sprinkler heads, irrigation lines, and other underground utilities during their grading and conditioning operations.

G. Final finish grades shall insure positive drainage of the site with all surface drainage away from buildings, walls, and toward roadways, swales, drains and catch basins.

H. Final grades shall be acceptable to the Owner's Representative before planting operations will be allowed to begin.

I. Planting surfaces shall be graded with no less than one (1) percent surface slope for positive drainage to catch basins and drain inlets.

3.4 PLANTING:

A. The layout of locations for plants and outlines of groundcover to be planted shall be approved on the site by the Owner's Representative, prior to their planting. All such locations shall be checked for possible interference with existing underground piping, prior to excavation of holes. If underground construction or utility lines are encountered in the excavation of planting areas, other locations for the planting may be selected by the Owner's Representative. Damage to existing utilities shall be the responsibility of the Contractor.

3.5 PLANTING TREES, SHRUBS AND VINES:

A. Planting holes shall be twice the diameter of the container size or as approved by the Owner's Representative, and in no case shall holes be too small to accommodate plant rootballs.

B. Excavation shall include the stripping and stacking of all acceptable soil encountered within the areas to be excavated for plant pits and planting beds. Protect all areas that are to be trucked over and upon which soil is to be temporarily stacked pending its re-use for the fillings of holes, pits and beds.

C. Excess soil, generated from the planting holes shall be spread evenly over the site by the Contractor.

D. All used containers shall be removed to the storage area or from the site by the Contractor.

E. The plants shall be planted at approved locations with the heretofore specified conditioner and soil planting backfill.

F. Water settle the planting pits to the rootball base levels prior to the placement of the plants. After setting the plants loosen any encircling roots before the remaining backfill material is hand tamped and settled around each rootball.

G. Each tree and shrub shall be placed in the center of the hole and shall be set plumb and held rigidly by the rootball in position until the planting backfill has been tamped around each root ball.

H. All plants shall be set at such a level that after settling they bear the same relationship to the surrounding finish grade as they bore to the soil in the container.

I. Planting tablets shall be placed in each tree or shrub planting hole at the following rates:

1. 15 - 7 gram tablets per 15 gallon container
2. 4 - 7 gram tablet per 6 inch of box size
3. 8 - 7 gram tablets per 5 gallon container
4. 3 - 7 gram tablet per each 1 gallon container
5. 1 - 7 gram tablet per groundcover plant

J. No plant will be accepted if the rootball is broken or cracked, either before, during or after the process of installation.

K. All plants shall be thoroughly watered into the full depth of each plant hole immediately after planting.

L. All trees, 24" box size and larger, shall be staked with two wood stakes driven into the ground on the north and south sides of the tree. The stakes shall be driven in plumb and secure outside of the tree rootball. Special care shall be taken that the driving in of the stake shall be does not damage the tree roots or rootball. Tree ties shall be fastened to each tree and stake by looping figure 8's with the inside diameter of the tie at 2 or 3 times the diameter of the tree and by nailing the back of the tie to the stake (see detailed drawings).

M. The staking shall be accomplished in such a manner as to insure the proper and healthy growth and the safety of the plants, property, and the public.

N. The Contractor shall be responsible for all surface and subsurface drainage required which may affect his guarantee of the trees, shrubs, and vines. Notify the Owner's Representative if detrimental subsurface drainage conditions exist.

O. Pruning after planting shall be required on all trees, shrubs and vines when necessary to provide the specified or approved standard shapes, form and/or sizes characteristic to each plant. Pruning may include thinning, topping, and/or cutting and shall be under the direction of the Owner's Representative. Cuts over 3/4 inch in diameter shall be painted with an approved tree sealant.

3.6 PLANTING GROUNDCOVERS:

A. Groundcovers shall be planted in the areas indicated on the drawings. The groundcover plants shall be rooted cuttings grown in flats, and shall remain in those flats until transplanting.

B. All groundcover plants shall be planted with moist soil around roots in staggered rows, evenly spaced at the intervals called out on the drawings.

C. The groundcover plants shall be planted sufficiently deep to cover all roots and shall be immediately sprinkled with water after planting until the entire area is soaked to the full depth of all holes.

3.7 MULCH APPLICATION:

A. In all shrub and tree areas indicated on the drawings to receive organic mulch apply 3" minimum depth of organic mulch, tapering to 1" at plants and at paving.

B. In all groundcover planting areas indicated on the drawings to receive organic mulch apply 3" minimum depth of organic mulch, tapering to 1" at plants.

3.9 POST FERTILIZATION:

A. Post Fertilization for all planting areas shall occur a rate of 15 lbs. per 1,000 sq. ft. applied at the end of the Plant Establishment/Maintenance period.

3.10 CLEAN UP:

A. As project progresses, the Contractor shall maintain all areas in a neat manner and remove unsightly debris as necessary, sweeping walks weekly. After completion of project, the Contractor shall remove all debris and containers used in accomplishing work. All sidewalks, asphalt, paving and concrete areas adjacent to plantings shall be washed down by the Contractor, and any stains or discolorations shall be removed prior to final acceptance of the work.

END OF SECTION

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SECTION 32 91 13

SOIL PREPARATION

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 planting soils specified by amending of existing site soil.

B. Related Requirements:

1. Section 32 05 10 "Imported Soil & Rock" for imported topsoil and mineral mulch.
2. Section 32 90 00 "Landscaping" for placing organic mulch.

1.3 DEFINITIONS

A. Soil Type 1: General Planting

B. Uniformly Smooth Soil Surface: A soil surface that has a consistent slope or elevation with no more than a 1/2” deviation within a 1,000 sq. ft. (10’x10’) area. Soil surface shall be free of depressions, pits, and high spots.

C. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

D. CEC: Cation exchange capacity.

E. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

F. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

G. Imported Soil: Soil that is transported to Project site for use.

H. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

I. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

J. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

K. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

L. Planting Soil: On-site soil, imported soil, or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

M. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

1.4 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Section 01 22 00 "Unit Prices."

1.5 BASIS OF DESIGN

A. The planting soil design is to be based on agricultural field testing recommendations of on-site soils.

1. When products are identified by manufacturer name with no additional notation, the use of that manufacturer name and product name is not intended to limit the selection of equal products by other manufacturers. However, use of equal products by other manufacturers is subject to the requirements of Section 01 25 00 “Substitution Procedures.”

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for application and use.
2. Include test data substantiating that products comply with requirements.
3. Include sieve analyses for aggregate materials.

4. Material Certificates and Laboratory Testing Results: Submit within 4 weeks of Notice to Proceed: For each type of bioretention soil, soil amendment and fertilizer and organic soil amendment before delivery to the site, according to the following:

   a. Manufacturer's qualified testing agency's certified analysis of standard products.
   b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
   c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
   d. Bioretention Soil
      1) Manufacturer certification that products meet or exceed all physical properties, endurance, performance, and packaging requirements.
      2) Bioretention soils test results must be from tests conducted within 120 days prior to delivery date to the project site.
      3) For projects installing more than 100 cubic yards of bioretention soil, provide batch-specific test results and certifications.
      4) Grain size analysis results of the sand component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
      5) Grain size analysis results of the sandy loam component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
      6) Grain size analysis results of compost component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
      7) Agricultural soil analysis results performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils
   e. Organic Soil Amendments
      1) Analysis of organic soil amendments by a qualified testing agency.
      2) Results of organic soil amendment tests conducted within 120 days prior to delivery date to the project site.
      3) Grain size analysis results performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
      4) Agricultural soil analysis results performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
      5) Compost: Submit the past 3 inspection reports from the local CalRecycle enforcement agency verifying compliance with specified Title14 requirements.

B. Samples: For bioretention soil and each bulk-supplied material, 1-quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: For each testing agency.

B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

C. Field quality-control reports.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soils testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1. Laboratories: Subject to compliance with requirements, provide testing by one of the following:

a. Way Point Laboratory, Inc., 4741 East Hunter Ave., Suite A, Anaheim, CA 92807.
b. Wallace Laboratories, 365 Coral Circle, El Segundo, CA 90245.

1.10 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on on-site soil and.

1. Notify District Construction Manager seven days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.11 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Project Inspector under the direction of the testing agency.

1. Number and Location of Samples: Minimum of, and three total for shrub areas representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.
2. Procedures: A representative sample shall consist of a composite of multiple sub-samples taken from the area under investigation, combined and then submitted. Discard the top inch of soil to avoid including debris that might contaminate the sample. Equipment for sampling may be a soil sampling tube, soil auger, spade, shovel, and/or trowel. Soil sampling tools shall be clean and not rusty. Do not sample if the soil is muddy, or excessively wet. Seal soil samples shall be sealed in airtight plastic bags.
3. Depth of Core Samples Type 1 and Type 2 Soils:
   a. On-Site Soils:

      1) In place at grade – 8”-10” depth
      2) After amending and fine grading – 6” to 8” depth

4. Labeling
   a. On-Site Soils: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth for on-site soils or source of material and suppliers name for all import soils.
5. Packaging and Shipping: Ship samples as directed by testing agency.
6. Reference Plant List: Provide a list of plants proposed for installation as indicated on the Drawings, and a copy of these specifications, to the testing agency.

1.12 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

1. Conduct soils tests for on-site soil a minimum of two (2) times.

   a. First Soils Test: Test in place on-site or stockpiled on-site soil to determine the condition of on-site soils. Provide one test location for every 10,000 sq. ft of plant bed (maximum of three). If on-site soils cannot meet the requirements of topsoil as defined herein, provide import topsoil as specified below.
   b. Second Soils Test: If the on-site soils can be amended to meet the requirements of topsoil as specified herein, complete a second series of soils testing after the soil has been amended and leached per the recommendation of the first soils test. If testing results are not in compliance with specifications, additional testing may be required by the Landscape Architect, at no additional cost to the Owner.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by the following method according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

   a. Hydrometer Method: Report percentages of sand, silt, and clay. Report percentage of gravel, if present.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.

4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA, including the following:
1. Percentage of water in saturation extract.
2. Electrical conductivity (ECe).
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Manganese-availability ppm.
10. Molybdenum ppm.
11. Iron ppm.
12. Sulfur ppm.
13. Boron ppm.
14. Zinc ppm.
15. Zinc availability ppm.
16. Copper ppm.
17. Chloride ppm.
18. Sodium ppm and sodium absorption ratio (SAR).
19. Soluble-salts ppm.
20. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
21. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

F. Recommendations: Based on the test results, testing agency shall provide interpretation of data and written recommendations for soil treatments, soil amendments to be incorporated, and required leaching, to produce satisfactory planting soil suitable for healthy, viable plants as indicated on Drawings. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients. Include results of the soil texture and percent by dry weight of soil organic matter. Include recommendations for remediation of phytotoxicity elements and deleterious materials. Include amount and length of time to perform leaching operations, if required.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight or volume per 1000 sq. ft. for 6-inch depth of soil and in weight or volume per cu. yd. of backfill mix.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight or volume per 1000 sq. ft. for 6-inch depth of soil and in weight or volume per cu. yd. of backfill mix.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.

B. On-Site Planting-Soil Type 1 – General Planting On-site soil, with the duff layer, if any, retained; modified to produce viable planting soil.

1. Amended Soil Composition: For bidding purposes blend unamended on-site soil with the following soil amendments and fertilizers in the following quantities to produce planting soil (actual quantities will be determined by soils test recommendations):

   a. Ratio of Loose Compost to Soil: 4 cu. yd. per 1000 sq. ft. per 6 inches, or part thereof, of amended soil depth.
   b. Weight of Soil Sulfur: 20 lbs. per 1000 sq. ft. per 6 inches, or part thereof, of amended soil depth.
   c. Weight of Iron Sulfate: 20 lbs. 1000 sq. ft. per 6 inches, or part thereof, of amended soil depth.
   d. Weight of Agricultural Gypsum: 100 lbs. per 1000 sq. ft. per 6 inches, or part thereof, of amended soil depth.
   e. Weight of Superphosphate: 8 lbs. per 1000 sq. ft. per 6 inches, or part thereof, of amended soil depth.
   f. Weight of Commercial Fertilizer: 200 lbs. per 1000 sq. ft. per 6 inches, or part thereof, of amended soil depth.
   g. Weight of Slow-Release Fertilizer: 20 lbs. per 1000 sq. ft. per 6 inches, or part thereof, of amended soil depth.
   h. Sand as required to increase infiltration rate to acceptable levels.

2. Additional Properties of on-site soil after amending and leaching:

   a. Soil reaction of pH 6 to 8 as measured in the saturation extract (Method 21a, USDA Handbook Number 60)
   b. Percent Organic Matter By Dry Weight

      1) Type 1 – General Planting areas Soils: 3 to 5 percent after leaching.

c. Salinity: The salinity range measured in the saturation extract (Method 3a, USDA Handbook Number 60) shall be 3.0 or less dS/m. If calcium and sulfate ions both exceed 20 milliequivalents per liter in the saturation extract, the maximum salinity shall be 5.0 dS/m.

d. Chloride: The maximum concentration of soluble chloride in the saturation extract (Method 3a, USDA Handbook Number 60) shall be 150 mg/l (parts per million) for ornamental planting and cool season turf, and 500 mg/l (parts per million) for warm season turf.

e. Boron: The maximum concentration of soluble boron in the saturation extract (Method 3a, USDA Handbook Number 60) shall be 1 mg/l (parts per million).

f. Sodium Absorption Ratio (SAR): The maximum SAR shall be 5 measured per Method 20b, USDA Handbook Number 60.

g. Carbon: Nitrogen ratio shall be less than 20:1

h. Aluminum: Available aluminum measured with the Ammonium Bicarbonate/DTPA Extraction shall be less than 5 parts per million.

i. Calcium Carbonate Content: Free calcium carbonate (limestone) shall not be present.

j. Phytotoxic Constituent, Herbicides, Hydrocarbons*:* Germination and growth of monocots and dicots shall not be restricted more than 10 percent compared to the reference soil. Total petroleum hydrocarbons shall not exceed 50 mg/kg dry soil measured per the modified EPA Method No. 8015. Total aromatic volatile organic hydrocarbons (benzene, toluene, xylene and ethylbenzene) shall not exceed 0.5 mg/kg dry soil measured per EPA Methods No. 8020.

k. Heavy Metals: The maximum permissible elemental concentration in the soil shall not exceed the following:

1) Total Threshold Concentration Limit (Ammonium Bicarbonate/DTPA Extraction TTLC Level) parts per million (mg/kilogram) dry weight basis:

a)	Antimony:	150 ppm.
b)	Arsenic:	50 ppm.
c)	Barium:	1,000 ppm.
d)	Beryllium:	7.5 ppm.
e)	Cadmium:	10 ppm.
f)	Chromium:	50 ppm.
g)	Cobalt:	800 ppm
h)	Copper:	250 ppm
i)	Lead:	50 ppm.
j)	Mercury:	2 ppm.
k)	Molybdenum:	3,500
l)	Nickel:	200 ppm.
m)	Selenium:	10 ppm.
n)	Silver:	50 ppm.
o)	Thallium:	70 ppm.
p)	Vanadium:	240 ppm.
q)	Zinc:	2,500 ppm.

2) If the soil pH is between 6 and 7, the maximum permissible elemental concentration shall be reduced 50 percent. No more than three metals shall be present at 50 percent or more of the above values.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
2. Class: O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
3. Form: Provide lime in form of ground calcitic limestone or ground mollusk shells.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur, and conforming to requirements of the California Food and Agricultural Code.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.

F. Sand: Clean, washed, natural or manufactured, free of toxic materials.

1. Sand finer than 100 mesh (0.15 mm): Less than 15%
2. Sand finer that 60 mesh (0.25 mm): Less than 40%
3. Sand larger than 32 mesh (0.5 mm): Minimum 15%

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well decomposed, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:

1. Compost shall be produced at a facility inspected and regulated by the Local Enforcement Agency for CalRecycle.

2. Comply with Title14 requirements of the Process to Further Reduce Pathogens (PFRP), Fecal coliform and Salmonella testing and pathogen and EPA, 40 CFR 503 regulations

3. Feedstock limited to leaves and plant parts only; includes straw and alfalfa.

4. Mushroom, manures, peat mosses, green waste and food waste composts are acceptable.

5. Composted wood products are conditionally acceptable (stable humus must be present). Wood products based on redwood or cedar are not acceptable. Wood derivatives, including sawdust and chipped construction waste are not acceptable.

6. Sewage sludge and animal waste are not acceptable.

7. Compost shall have a dark brown color and a soil like odor.

8. Compost exhibiting a sour or putrid smell, containing recognizable grass or leaves, or is hot (120F) upon delivery or rewetting is not acceptable.

9. Comply with Title14 requirements of the Process to Further Reduce Pathogens (PFRP), Fecal coliform and Salmonella testing and pathogen and EPA, 40 CFR 503 regulations.

10. Particle Size: The maximum particle size shall be 0.5-inch

11. Calcium carbonate shall not be present if to be applied on alkaline soils.

12. The salt content shall be less than 6 millimho/cm @ 25° C. (ECe less than 6) in a saturated paste extract.

13. Additional Properties:

Property	**Method**	**Requirement**
pH, Units	Saturation Paste	5.5 to 8
Soluble-Salt Concentration		Less than 5 dS/m
SAR		Less than 5
Chloride	Method 3a, USDA	Less than 1000 mg/l
EC, dS/m	Saturation Extract	0 to 10
Boron, ppm	Saturation Extract	less than 1
Silicone Content (Acid insoluble ash)		Less than 50%
Moisture content by weight, %	Gravimetric	35-55%
Bulk Density, lbs/cubic yard		500 to 1100
Organic Matter, % of Dry Weight	Loss on Ignition	50-65%
Carbon to Nitrogen Ratio		Less than 20:1
Maturity	Solvita	5 or above
Stability	Solvita	5 or above
Particle Size	Sieve Analysis	
Pass 3/4 inch sieve		98%
Pass 1/2-inch sieve		90%-100%
Pass #4 screen		80% or more
CA Title 22 Metals	Title 22	
Antimony (Sb)		Less than 150 ppm
Arsenic (As)		Less than 50 ppm

Barium (Ba)		Less than 1,000 ppm
Beryllium (Be)		Less than 7.5 ppm
Cadmium (Cd)		Less than 10 ppm
Chromium (Cr)		Less than 50 ppm
Cobalt (Co)		Less than 800 ppm
Copper (Cu)		Less than 250 ppm
Lead (Pb)		Less than 50 ppm
Mercury (Hg)		Less than 2 ppm
Molybdenum (Mo)		Less than 3,500 ppm
Nickel (Ni)		Less than 200 ppm
Selenium (Se)		Less than 10 ppm
Silver (AG)		Less than 50 ppm
Thallium (TI)		Less than 70 ppm
Vanadium (V)		Less than 240 ppm
Zinc (Zn)		Less than 2,500 ppm
Pathogen		
Salmonella	Title 14	< 3 MPN per 4 gms
Fecal Coliform		<1000 MPN per 1 gm
Physical contaminants		
Plastic Metal and Glass, %> 4mm	% by Weight	< 1
Sharps, % > 4mm	% by Weight	0

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, water soluble; a minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, minimum 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Gro-Power.
2) Wilbur-Ellis Agribusiness.
3) Kellogg Garden Products.
4) Or Equal.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Gro-Power.
2) Wilbur-Ellis Agribusiness.
3) Kellogg Garden Products.
4) Or Equal.

D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1

A. The quantities given below are for bidding purposes. If unsatisfactory soil conditions should be encountered over the course of the work the Contractor shall alert the Owner's Representative who will obtain a soil sample for agronomic testing.

3.2 SOIL CONDITIONING, FERTILIZING AND ROTOTILLING:

A. After planting areas have been and graded, rip soil to a depth of 12" deep. The following rates of soil conditioning and amendment materials shall be evenly spread over all planting areas less than 2:1 in slope and shall be thoroughly scarified to an average depth of six (6) inches by roto-tilling a minimum of two (2) alternating passes, followed by six (6) inches of water leaching performed in three (3) applications of two (2) inches each.

1. Soil Sulfur: 30 lbs./1,000 sq.ft.
2. Soil Conditioner: 3 cu.yd./1,000 sq.ft.
3. Wetting Agent: 1 quart/1,000 sq. ft.
4. Gypsum: 50 lbs/1,000 sq. ft.
5. Soil Activator: 100 lbs/1000 sq. ft.
6. Soil Inoculant: 20 lbs/1000 sq. ft.

B. Slopes 2:1 and steeper, omit soil conditioner application and tilling and treat as follows:

1. Apply flowable gypsum at the rate of 2 quarts per 10 gallons of water per 1,000 sq. ft.
2. Apply iron sulfate at the rate of 3 pounds per 1,000 sq. ft.
3. Apply wetting agent at the rate of 2 ounces per 1,000 sq. ft.

4. Spray 15-15-15 fertilizer at the rate of 5 pounds per 1,000 sq. ft.

C. Planting backfill in tree and shrub planting areas shall be a thoroughly blended mixture of excavated soil from the planting pits and soil amendments at the following mixture:

1. Soil Conditioner 20%
2. On Site Soil 80%
3. Gypsum 3 lbs.
4. Soil Sulfur 2 lbs./cu. yd.
5. Soil Activator 15 lbs./cu. yd.
6. Soil Inoculant 3 lbs./cu. Yd.

3.2 PLACING AND MIXING TYPE 1 – GENERAL PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended on-site soil with amendments on-site to produce required planting soil. Do not apply materials or till if on-site soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Cross rip subgrade to a minimum depth of 3 inches. Remove stones, sticks, roots, rubbish, and other extraneous matter 1-inch and larger in any dimension, and legally dispose of off District's property.

C. Apply, add soil amendments, and mix with machine rototill approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix with machine rototill thoroughly into top 4 inches of subgrade. Machine rototill a minimum of two alternating passes, crossing at 90 degree angles. Spread remainder of planting soil.

D. Mixing: Spread unamended soil to total depth of 12 inches, but not less than required to meet finish grades after mixing machine rototill with amendments and natural settlement. Do not spread if soil or subgrade is muddy or excessively wet.

1. Amendments: Apply soil amendments, compost, and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil by machine rototill to produce planting soil. Machine rototill a minimum of two alternating passes, crossing at 90 degree angles.

   a. Mix fertilizer with planting soil no more than seven days before planting.

2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 6 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

E. Compaction: Compact each blended lift of planting soil to 80 percent minimum to 85 percent maximum of maximum Standard Proctor density according to ASTM D 698.

F. Leaching: Leach amended soils with a minimum of 6” of water over a 2 week period or as determined by the soils test recommendations to reduce SAR, ECE, and Sodium to acceptable levels as determined by the soils test recommendations.

3.3 BLENDING TYPE 1 – GENERAL PLANTING SOIL IN PLACE

A. General: Mix amendments with in-place, unamended on-site soil to produce required planting soil. Do not deep rip, apply materials, or rototill if on-site soil or subgrade is frozen, muddy, or excessively wet.

B. Deep Ripping: Deep rip and loosen planting areas to a depth of 12 inches in two directions, crossing at 90 degree angles. Access roads used during construction activities within planting areas shall be deep ripped and loosened to a depth of 3 feet in two opposite directions, crossing at 90 degree angles.

C. Preparation: Machine Rototill unamended on-site soil in planting areas to a minimum depth of 6 inches. Machine rototill a minimum of two alternating passes, crossing at 90 degree angles. Remove stones, sticks, roots, rubbish, and other extraneous matter 1 inch and larger in any dimension, and legally dispose of them off District's property.

D. Mixing: Apply soil amendments, compost, and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil with machine rototill. Rototill a minimum of two alternating passes to a minimum depth of 6 inches, crossing at 90 degree angles to produce planting soil.

1. Mix fertilizer with planting soil no more than seven days before planting.

E. Compaction: Compact blended planting soil to 75 to 80 percent of maximum Standard Proctor density according to ASTM D 698.

F. Leaching: Leach amended soils with a minimum of 6” of water over a 2 week period or as determined by the soils test recommendations to reduce SAR, ECE, and Sodium to acceptable levels as determined by the soils test recommendations.

G. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake to remove ridges, and fill depressions to meet finish grades. Rake out and remove all rocks and material 1/2-inch size and larger. Prior to approval, remove ridges greater than 1/2” and fill depressions greater than 1/2” within a 1,000 sq. ft. (10’x10’) area.

H. Finish grades shall be as indicated on the Drawings.

I. Finish grades shall be measured at the top surface of surface materials.

J. Molding and rounding of the grades shall be provided at all changes of slope.

K. Take every precaution to protect and avoid damage to new and existing sprinkler heads, irrigation lines, and other underground utilities during grading and conditioning operations.

L. Finish grades shall be acceptable to Project Inspector before planting operations begin.

M. Finish grade shall ensure positive drainage of the site with all surface drainage away from buildings, other structures, and walls with flow towards storm drains and catch basins.

N. Planting surfaces shall be graded with no less than 2 percent surface slope for positive drainage.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform the following tests and inspections.

1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.

B. Soil will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.5 PROTECTION

A. Protection Zone: Identify protection zones according to Section 01 56 39 "Temporary Tree and Plant Protection."

B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation or other digging unless otherwise indicated.

C. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Landscape Architect and replace contaminated planting soil with new planting soil.

3.6 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off District's property unless otherwise indicated.

END OF SECTION

SECTION 33 30 00

SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes gravity-flow, nonpressure and force-main, pressure sanitary sewerage outside the building, with the following components:

1. Special fittings for expansion and deflection.
2. Backwater valves.
3. Cleanouts.
4. Corrosion-protection piping encasement.
5. Precast concrete manholes.

1.2 REFERENCED STANDARDS

A. The editions and specifications and standards referenced herein, published by the following organizations apply to the construction only to the extent specified by the reference.

1. Standard Specifications:

a. Standard Specifications for Public Works Construction, (Current Edition).
b. Standard Special Provisions of the Regional Standards Committee.
c. California Department of Transportation, "Manual of Traffic Controls, for Construction and Maintenance Work Zones", (Current Edition), Document No. 869159, filed current date.

2. Standard Drawings:

a. City of Fontana Standard Plans, (current edition).
b. American Water Works Association (AWWA).
c. UNI-BELL Plastic Pipe Association (UNI).

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene-monomer rubber.

C. FRP: Fiberglass-reinforced plastic.

D. LLDPE: Linear low-density, polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

H. RTRF: Glass-fiber-reinforced, thermosetting-resin fitting.

I. RTRP: Glass-fiber-reinforced, thermosetting-resin pipe.

J. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

B. Force-Main, Pressure-Piping Pressure Rating: At least equal to system operating pressure but not less than 100 psig.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Submit manufacturers catalog data on pipe to be supplied.
2. Submit affidavit of compliance with this spec and all reference specifications signed by authorized representative of the manufacturers.
3. Special pipe fittings.
4. Backwater valves.

B. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

C. Field quality-control test reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by City or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify City's Representative no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without City's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy classes.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

C. Shielded, Stainless-Steel Couplings: CISPI 310, with ASTM A 666, Type 301, stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

1. Manufacturers:

a. ANACO.
b. Dallas Specialty & Mfg. Co.
c. Fernco Inc.
d. Ideal Div.; Stant Corp.
e. Mission Rubber Company; a division of MCP Industries, Inc.
f. Tyler Pipe; Soil Pipe Div.

2. Couplings for NPS 1-1/2 to NPS 4: 2-1/8-inch- wide shield with 2 bands.
3. Couplings for NPS 5 and NPS 6: 3-inch- wide shield with 4 bands.
4. Couplings for NPS 8 and NPS 10: 4-inch- wide shield with 4 bands.

D. Heavy-Duty, Shielded, Stainless-Steel Couplings, NPS 10 and Smaller: With ASTM A 666, Type 301 or Type 304, stainless-steel shield; 2 or more stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve

1. Manufacturers:

a. ANACO.
b. Clamp-All Corp.
c. Dallas Specialty & Mfg. Co.
d. Ideal Div.; Stant Corp.
e. Mission Rubber Company; a division of MCP Industries, Inc.
f. Tyler Pipe; Soil Pipe Div.

2. Couplings for NPS 1-1/2 to NPS 4: 3 inches.
3. Couplings for NPS 5 to NPS 10: 4 inches.

E. Heavy-Duty, Shielded, Stainless-Steel Couplings, NPS 12 and NPS 15: With ASTM A 666, Type 301 or Type 304, stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

1. Manufacturers:

a. ANACO.
b. Ideal Div.; Stant Corp.
c. Mission Rubber Company; a division of MCP Industries, Inc.
d. Tyler Pipe; Soil Pipe Div.

2. Couplings: 5-1/2-inch- wide shield with 6 bands.

F. Heavy-Duty, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.

1. Manufacturers:

a. MG Piping Products Co.

2. Couplings for NPS 1-1/2 to NPS 4: 2-1/8-inch- wide housing with 2 bolts.
3. Couplings for NPS 5 and NPS 6: 3-1/8-inch- wide housing with 4 bolts.
4. Couplings for NPS 8 and NPS 10: 4-inch- wide housing with 4 bolts.

G. Unshielded Couplings: ASTM C 1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. ANACO.

2. Couplings for NPS 1-1/2 to NPS 4: Sleeve with two bands.

2.5 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

A. Pipe: ASTM A 746, for push-on joints.

B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153, for push-on joints.

D. Gaskets: AWWA C111, rubber.

2.6 ABS PIPE AND FITTINGS

A. ABS Sewer Pipe and Fittings: ASTM D 2751, with bell-and-spigot ends for gasketed joints.

1. NPS 3 to NPS 6: SDR 35.
2. NPS 8 to NPS 12: SDR 42.
3. Gaskets: ASTM F 477, elastomeric seals.

2.7 PVC PIPE AND FITTINGS

A. PVC Cellular-Core Pipe and Fittings: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness pipe with ASTM D 3034, SDR 35, socket-type fittings for solvent-cemented joints.

B. PVC Sewer Pipe and Fittings:

1. Pipe and Fittings: Shall conform to ASTM D 3033 or ASTM D 3034, shall be SDR 35, with ends suitable for elastomeric gasket joints. Pipe shall meet requirements of UNI-B-10-88.
2. Joints and Jointing Material: Utilize an integral bell and spigot with a solid cross section rubber gasket. Joints shall conform to ASTM D 3212. Gaskets shall conform to ASTM F 477.
3. Pipe Stiffness: Minimum pipe stiffness (@ 5% deflect) shall be 46 for all sizes when tested in accordance with ASTM D 2412.
4. Flattening: There shall be no evidence of splitting, cracking, or breaking when the pipe is tested as follows:

a. Flatten specimen of pipe, six inches long between parallel plates in a suitable press until the distance between the plates is forty percent of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is completed within two to five minutes.

5. Products: Ringtite greenbell PVC sewer pipe, Johns-Manville, Denver, Colorado; Fluidtite PVC sewer pipe, Certainteed Corporation, Anaheim, California; or equal.

C. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-[1] [2] wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

D. 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.

2.8 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Concrete Pipes: ASTM C 443, rubber.
2. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
3. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
4. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Dallas Specialty & Mfg. Co.
b. Fernco Inc.
c. Logan Clay Products Company (The).
d. Mission Rubber Company; a division of MCP Industries, Inc.
e. NDS Inc.
f. Plastic Oddities, Inc.

D. Shielded, Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg.
b. Dallas Specialty & Mfg. Co.

c. Mission Rubber Company; a division of MCP Industries, Inc.

E. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

1. Manufacturers:

a. Fernco Inc.
b. Logan Clay Products Company (The).
c. Mission Rubber Company; a division of MCP Industries, Inc.

F. Nonpressure-Type, Rigid Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. ANACO.

2.9 PRESSURE-TYPE PIPE COUPLINGS

A. Reducing or transition, metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig minimum pressure rating and ends of same sizes as piping to be joined.

B. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

1. Manufacturers:

a. Cascade Waterworks Mfg.
b. Dresser, Inc.; DMD Div.
c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
d. JCM Industries.
e. Romac Industries, Inc.
f. Smith-Blair, Inc.
g. Viking Johnson.

2. Center-Sleeve Material: Stainless steel.
3. Gasket Material: Natural or synthetic rubber.
4. Metal Component Finish: Corrosion-resistant coating or material.

C. Split-Sleeve Couplings: With split sleeve with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.

1. Manufacturers:

a. Brico Industries.

2. Sleeve Material: Stainless steel.

3. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
4. Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
5. Metal Component Finish: Corrosion-resistant coating or material.

2.10 SPECIAL PIPE FITTINGS

A. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include 2 gasketed ball-joint sections and 1 or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.

1. Manufacturers:

a. EBAA Iron Sales, Inc.
b. Romac Industries, Inc.
c. Star Pipe Products.

B. Ductile-Iron Deflection Fittings: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for up to 15 degrees of deflection.

1. Manufacturers:

a. EBAA Iron Sales, Inc.

C. Ductile-Iron Expansion Joints: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron or steel with protective coating, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for expansion indicated.

1. Manufacturers:

a. Dresser, Inc.; DMD Div.
b. EBAA Iron Sales, Inc.
c. JCM Industries.
d. Smith-Blair, Inc.

2.11 BACKWATER VALVES

A. Gray-Iron Backwater Valves: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.

1. Manufacturers:

a. Josam Company.
b. Smith, Jay R. Mfg. Co.
c. Wade Div.; Tyler Pipe.
d. Watts Industries, Inc.

e. Watts Industries, Inc.; Enpoco, Inc. Div.
f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

2. Horizontal Type: With swing check valve and hub-and-spigot ends.
3. Combination Horizontal and Manual Gate-Valve Type: With swing check valve, integral gate valve, and hub-and-spigot ends.
4. Terminal Type: With bronze seat, swing check valve, and hub inlet.

B. PVC Backwater Valves: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

1. Manufacturers:

a. Canplas Inc.
b. IPS Corporation.
c. NDS Inc.
d. Plastic Oddities, Inc.
e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Light Commercial Specialty Plumbing Products; Zurn Plumbing Products Group.

2.12 CLEANOUTS

A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

1. Manufacturers:

a. Josam Company.
b. MIFAB Manufacturing Inc.
c. Smith, Jay R. Mfg. Co.
d. Wade Div.; Tyler Pipe.
e. Watts Industries, Inc.
f. Watts Industries, Inc.; Enpoco, Inc. Div.
g. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

2. Top-Loading Classification: Medium duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

1. Manufacturers:

a. Canplas Inc.
b. IPS Corporation.
c. NDS Inc.
d. Plastic Oddities, Inc.

e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Light Commercial Specialty Plumbing Products; Zurn Plumbing Products Group.

2.13 CORROSION-PROTECTION PIPING ENCASEMENT

A. Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105.

1. Form: Sheet or tube.
2. Material: LLDPE film of 0.008-inch minimum thickness.
3. Material: LLDPE film of 0.008-inch minimum thickness or high-density, crosslaminated PE film of 0.004-inch minimum thickness.
4. Material: High-density, crosslaminated PE film of 0.004-inch minimum thickness.
5. Color: Black.

2.14 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.15 MISCELLANEOUS MATERIALS

A. Paint: SSPC-Paint 16.

B. PE Sheeting: ASTM D 4397, with at least 8-mil thickness or other equivalent, impervious material.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 STORAGE OF MATERIALS

A. Inspect all materials delivered to the site for damage. Store materials on site in enclosures or under protective covering out of direct sunlight. Do not store materials directly on ground. Keep inside of pipes and fittings free of dirt and debris.

3.3 PIPING APPLICATIONS

A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.

a. Shielded flexible or rigid couplings for same or minor difference OD pipes.
b. Unshielded, increaser/reducer-pattern, flexible or rigid couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

B. Special Pipe Fittings: Use for pipe expansion and deflection. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

C. Gravity-Flow, Nonpressure Sewer Piping: Use the following pipe materials for each size range:

1. NPS 3: Hub-and-spigot, Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. NPS 3: Hubless cast-iron soil pipe and fittings; shielded, stainless-steel couplings; and coupled joints.
3. NPS 3: NPS 6 ductile-iron, gravity sewer pipe or NPS 3 or NPS 4 ductile-iron pressure pipe; ductile-iron standard or compact fittings; gaskets; and gasketed joints.
4. NPS 3: Stainless-steel drainage pipe and fittings, gaskets, and gasketed joints. Use EPDM-compound gaskets, unless otherwise indicated. Use nitrile-rubber-compound gaskets for wastes containing gasoline or oil.
5. NPS 3: ABS, SDR 35, sewer pipe and fittings; gaskets; and gasketed joints.
6. NPS 3: PVC water-service pipe; PVC Schedule 40, water-service-pipe fittings; and solvent-cemented joints.
7. NPS 3: NPS 4 PVC sewer pipe and fittings, gaskets, and gasketed joints.

8. NPS 4: Hub-and-spigot, Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
9. NPS 4: Hubless cast-iron soil pipe and fittings; shielded, stainless-steel couplings; and coupled joints.
10. NPS 4: NPS 6 ductile-iron, gravity sewer pipe or NPS 4 ductile-iron pressure pipe; ductile-iron standard or compact fittings; gaskets; and gasketed joints.
11. NPS 4: Stainless-steel drainage pipe and fittings, gaskets, and gasketed joints. Use EPDM-compound gaskets, unless otherwise indicated. Use nitrile-rubber-compound gaskets for wastes containing gasoline or oil.
12. NPS 4: ABS, SDR 35, sewer pipe and fittings; gaskets; and gasketed joints.
13. NPS 4: PVC water-service pipe; PVC Schedule 40, water-service-pipe fittings; and solvent-cemented joints.
14. NPS 4: PVC sewer pipe and fittings, gaskets, and gasketed joints.
15. NPS 5 and NPS 6: Hub-and-spigot, Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
16. NPS 5 and NPS 6: Hubless cast-iron soil pipe and fittings; shielded, stainless-steel couplings; and coupled joints.
17. NPS 5 and NPS 6: NPS 6 ductile-iron, gravity sewer pipe; ductile-iron standard or compact fittings; gaskets; and gasketed joints.
18. NPS 5 and NPS 6: NPS 6 stainless-steel drainage pipe and fittings, gaskets, and gasketed joints. Use EPDM-compound gaskets, unless otherwise indicated. Use nitrile-rubber-compound gaskets for wastes containing gasoline or oil.
19. NPS 5 and NPS 6: NPS 6 ABS, SDR 35, sewer pipe and fittings; gaskets; and gasketed joints.
20. NPS 5 and NPS 6: NPS 6 cellular-core PVC pipe, PVC sewer pipe fittings, and solvent-cemented joints.
21. NPS 5 and NPS 6: NPS 6 PVC sewer pipe and fittings, gaskets, and gasketed joints.
22. NPS 5 and NPS 6: NPS 6 Class [1] [2] [3], nonreinforced-concrete sewer pipe and fittings, gaskets, and gasketed joints.
23. NPS 8 and NPS 10: Hub-and-spigot, Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
24. NPS 8 and NPS 10: Hubless cast-iron soil pipe and fittings; shielded, stainless-steel couplings; and coupled joints.
25. NPS 8 and NPS 10: Ductile-iron, gravity sewer pipe; ductile-iron standard or compact fittings; gaskets; and gasketed joints.
26. NPS 8 and NPS 10: ABS, SDR 42, sewer pipe and fittings; gaskets; and gasketed joints.
27. NPS 8 and NPS 10: Cellular-core PVC pipe, PVC sewer pipe fittings, and solvent-cemented joints.
28. NPS 8 and NPS 10: PVC sewer pipe and fittings, gaskets, and gasketed joints.
29. NPS 8 and NPS 10: PVC profile gravity sewer pipe and fittings, gaskets, and gasketed joints.
30. NPS 12 and NPS 15: Hub-and-spigot, Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
31. NPS 12 and NPS 15: Hubless cast-iron soil pipe and fittings; heavy-duty, shielded, stainless-steel couplings; and coupled joints.
32. NPS 12 to NPS 16: Ductile-iron, gravity sewer pipe; ductile-iron standard or compact fittings; gaskets; and gasketed joints.
33. NPS 12: ABS, SDR 42, sewer pipe and fittings; gaskets; and gasketed joints.

34. NPS 12 and NPS 15: PVC sewer pipe and fittings, gaskets, and gasketed joints.
35. NPS 12 and NPS 15: PVC profile gravity sewer pipe and fittings, gaskets, and gasketed joints.
36. NPS 12 and NPS 15: Reinforced-concrete sewer pipe and fittings, gaskets, and gasketed joints.
37. NPS 18 to NPS 24: Ductile-iron, gravity sewer pipe; ductile-iron standard or compact fittings; gaskets; and gasketed joints.
38. NPS 18 to NPS 24: PVC sewer pipe and fittings, gaskets, and gasketed joints.
39. NPS 18 to NPS 24: PVC profile gravity sewer pipe and fittings, gaskets, and gasketed joints.

3.4 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install pipe in accordance with ASTM D 2321, UNI-B-5 and the following:

C. Inspect each pipe and fitting before lowering the pipe or fitting into the trench. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.

D. Use implements, tools, and facilities for the safe and proper protection of the pipe. Handle pipe in such a manner as to avoid any physical damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

E. When installing piping in trenches, do not deviate more than 1 inch from line or 1/4 inch from grade. Measure for grade at the pipe invert.

F. Grade the bottom of the trench to the line and grade to which the pipe is to be laid, with allowance for pipe thickness. Remove hard spots that would prevent a uniform thickness of bedding. Before laying each section of the pipe, check the grade with a straightedge and correct any irregularities found. The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between bell holes, except that the grade may be disturbed for the removal of lifting tackle.

G. At the location of each joint, dig bell (joint) holes in the bottom of the trench and at the sides to permit visual inspection of the entire joint.

H. Provide and maintain means and devices at all times to remove and dispose of all water entering the trench during the process of pipelaying. The trench shall be kept dry until the pipelaying and jointing are completed. Removal of water shall be in conformance with specifications in Section 01065.

I. When the pipelaying is not in progress, including the noon hours, close the open ends of pipe. Do not permit trench water, animals, or foreign material to enter the pipe.

J. Lay pipe without break, upgrade from structure to structure, with the bell ends of the pipe upgrade.

K. Do not use the pipe as a drain for removing water that has infiltrated into the trench.

L. After joint assembly, bring the bedding material up to 1 foot above the top of the pipe. Place and compact the imported sand as directed in Section 02300. The remainder of the backfill shall be native earth backfill, installed per Section 02300.

M. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

N. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

O. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.

P. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with 36-inch minimum cover.
4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install ductile-iron, gravity sewer piping according to ASTM A 746.
7. Install ductile-iron and special fittings according to AWWA C600 or AWWA M41.
8. Install stainless-steel drainage piping according to ASME A112.3.1.
9. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
10. Install PVC cellular-core piping according to ASTM D 2321 and ASTM F 1668.
11. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
12. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
13. Install fiberglass sewer piping according to ASTM D 3839 and ASTM F 1668.
14. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
15. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

Q. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:

1. Hub-and-spigot, cast-iron soil pipe.
2. Hubless cast-iron soil pipe and fittings.

3. Ductile-iron pipe and fittings.
4. Special pipe fittings.

R. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.5 PIPE JOINT CONSTRUCTION

A. Apply the joint manufacturer's lubricant to the pipe spigot to assemble the joint. Follow the manufacturer's instructions. Make joints water tight and root tight.

B. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
5. Join ductile-iron and special fittings according to AWWA C600 or AWWA M41.
6. Join stainless-steel drainage piping according to ASME A112.3.1.
7. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
8. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
9. 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.
10. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
11. Join fiberglass sewer piping according to ASTM D 4161 for elastomeric-seal joints.
12. Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
13. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
14. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.

C. Join force-main, pressure piping according to the following:

1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
2. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
3. Join PVC pressure piping according AWWA M23 for gasketed joints.
4. Join PVC water-service piping according ASTM D 2855.
5. Join dissimilar pipe materials with pressure-type couplings.

3.6 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318/318R.

3.7 BACKWATER VALVE INSTALLATION

A. Install horizontal-type backwater valves in piping where indicated.

B. Install combination horizontal and manual gate valve type in piping and in manholes where indicated.

C. Install terminal-type backwater valves on end of piping and in manholes where indicated. Secure units to sidewalls.

3.8 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use light-duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use medium-duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use heavy-duty, top-loading classification cleanouts in vehicle-traffic service areas.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.9 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 15 Section "Sanitary Waste and Vent Piping."

B. Connect pressure, force-main piping to building's sanitary force mains specified in Division 15 Section "Sanitary Waste and Vent Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Connect to grease, oil, or sediment interceptors specified in Division 2 Section "Interceptors."

3.10 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch-thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Backfill to grade according to Division 2 Section "Earthwork."

3.11 IDENTIFICATION

A. Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.12 TESTING FOR ALIGNMENT

A. After the pipe has been installed, tested for leakage, backfilled to existing grade, and manholes raised to grade and resurfaced, "ball" the pipe from manhole with a sewer scrubbing ball. After balling the pipe, perform the following.

B. "Mirror" straight sewers and inlet/outlet ends of curvilinear sewers. Perform balling and mirroring in the presence of the City's Representative to test for alignment, grade, damage or defective pipe in place, or any other type of faulty installation. Should balling and mirroring indicate any faulty installation of the pipe, repairs or replacements shall be made at the Contractor's expense.

3.13 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test for leakage by means of a water test. Test each section of pipe between manholes, along with the manholes.
3. Even though a section may have previously passed the leakage test, test each section of sewer subsequent to the last backfill compacting operation in which heavy compaction equipment may have damaged or affected the required watertight integrity of the pipe, structure, or appurtenance.
4. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
5. Submit separate report for each test.
6. WATER TEST
    a. Test each section of pipe between two successive structures by closing the lower end of the pipe to be tested and the inlet pipe of the upper structure

with plugs or stoppers. Fill the pipe and structure with water to a point 4 feet above the invert of the open pipe in the upper structure, or to a height of 10 feet above the invert of the sewer in the lower structure, whichever gives the less hydrostatic pressure on the lower structure.

b. The total leakage shall be the decrease in volume of water in the upper structure. The leakage shall not exceed 0.025 gpm per inch of nominal diameter of pipe per 1,000 feet of sewer pipe being tested. Do not use the length of lateral connections in computing the length of pipe being tested.

c. If the leakage is greater than allowed, overhaul the pipe and, if necessary, replace and relay until the joints and pipe comply with this test. Complete tests before trench is paved.

7. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
8. Option: Test plastic gravity sewer piping according to ASTM F 1417.
9. Option: Test concrete gravity sewer piping according to ASTM C 924.
10. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig.
11. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
12. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
13. Manholes: Perform hydraulic test according to ASTM C 969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.14 CLEANING

A. Clean interior of piping of dirt and superfluous material.

END OF SECTION 33 30 00

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SECTION 33 40 00

STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes gravity-flow, nonpressure storm drainage outside the building, with the following components:

1. Cleanouts.
2. Drains.
3. Precast concrete catch basins.

1.2 REFERENCED STANDARDS

A. The editions and specifications and standards referenced herein, published by the following organizations apply to the construction only to the extent specified by the reference.

B. Standard Specifications:

1. Standard Specifications for Public Works Construction, (Current Edition).
2. Standard Special Provisions of the Regional Standards Committee.
3. California Department of Transportation, "Manual of Traffic Controls, for Construction and Maintenance Work Zones", (Current Edition), Document No. 869159, filed current date.

C. Standard Drawings:

1. City of Fontana Standard Plans (current edition).
2. American Water Works Association (AWWA).
3. UNI-BELL Plastic Pipe Association (UNI).

D. American Society for Testing Materials (ASTM) publications shall apply as referenced:

1. C 76-85a Reinforced Concrete, Culvert, Storm Drain and Sewer Pipe.
2. C 150 85a Cement, Portland.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene-monomer rubber.

B. LLDPE: Linear low-density, polyethylene plastic.

C. PE: Polyethylene plastic.

D. PP: Polypropylene plastic.

E. PVC: Polyvinyl chloride plastic.

F. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water. Pipe joints shall be at least silttight, unless otherwise indicated.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Submit manufacturers catalog data on pipe to be supplied.
2. Drains.
3. Channel drainage systems.
4. Storage and leaching chambers.
5. Manufacturer’s confirmation that products supplied comply with referenced standards.

B. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

C. Field quality-control test reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

D. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify City's Representative no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without City's Representative's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.3 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 10 and Smaller: AASHTO M 252M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
2. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.
3. Corrugated PE Pipe and Fittings NPS 12 to NPS 48: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
4. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
5. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

B. Corrugated PE Pipe and Fittings NPS 56 and NPS 60: AASHTO MP7, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
2. Soiltight Couplings: AASHTO MP7, corrugated, matching pipe and fittings.

2.4 PVC PIPE AND FITTINGS

A. PVC Cellular-Core Pipe and Fittings: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness pipe with ASTM D 3034, SDR 35, socket-type fittings for solvent-cemented joints.

B. PVC Sewer Pipe and Fittings: Conforming to ASTM D 3033 or ASTM D 3034; SDR 35, with ends suitable for elastomeric gasket joints.

1. Pipe: Meeting requirements of UNI-B-10-88.
2. Joints and Jointing Material: Utilize an integral bell and spigot with a solid cross-section rubber gasket. Joints shall conform to ASTM D 3212. Gaskets shall conform to ASTM F 477.
3. Pipe Stiffness: Minimum of 46, at 5 percent deflection, for all sizes when tested in accordance with ASTM D 2412.
4. Flattening: Showing no evidence of splitting, cracking or breaking when tested as follows:

    a. Flatten specimen of 6-inch-long pipe between parallel plates in a suitable press until the distance between the plates is 40 percent of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is completed within two to five minutes.

5. Products: Subject to compliance with requirement, provide one of the following, or equal:

    a. Johns-Manville; Ringtite Greenbell PVC sewer pipe.
    b. Certainteed Corporation; Fluidtite PVC sewer pipe.

C. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-[1] [2] wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

D. 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.

2.5 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Dallas Specialty & Mfg. Co.
b. Fernco Inc.
c. Logan Clay Products Company (The).
d. Mission Rubber Company; a division of MCP Industries, Inc.
e. NDS Inc.
f. Plastic Oddities, Inc.

D. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg.
b. Dallas Specialty & Mfg. Co.
c. Mission Rubber Company; a division of MCP Industries, Inc.

E. Ring-Type Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

1. Manufacturers:

a. Fernco Inc.
b. Logan Clay Products Company (The).
c. Mission Rubber Company; a division of MCP Industries, Inc.

F. Nonpressure-Type Rigid Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. ANACO.

2.6 PRESSURE-TYPE PIPE COUPLINGS

A. Reducing or transition, metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig minimum pressure rating and ends of same sizes as piping to be joined.

B. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

1. Manufacturers:

a. Cascade Waterworks Mfg.
b. Dresser, Inc.; DMD Div.
c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
d. JCM Industries.
e. Romac Industries, Inc.
f. Smith-Blair, Inc.
g. Viking Johnson.

2. Center-Sleeve Material: Manufacturer's standard.
3. Gasket Material: Natural or synthetic rubber.
4. Metal Component Finish: Corrosion-resistant coating or material.

C. Split-Sleeve Couplings: With split sleeve with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.

1. Manufacturers:

a. Brico Industries.

2. Sleeve Material: Manufacturer's standard.
3. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
4. Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
5. Metal Component Finish: Corrosion-resistant coating or material.

2.7 CLEANOUTS

A. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

1. Manufacturers:

a. Canplas Inc.
b. IPS Corporation.
c. NDS Inc.
d. Plastic Oddities, Inc.
e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Industries, Inc.; Zurn Light Commercial Specialty Plumbing Products.
g. <Insert manufacturer's name.>

2.8 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water-cementitious materials ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.9 CATCH BASINS

A. Standard Precast Concrete Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

1. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
2. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
3. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
4. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
5. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
6. Grade Rings: Include 2 or 3 reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
7. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Designed Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.

1. Joint Sealants: ASTM C 990, bitumen or butyl rubber.
2. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
3. Grade Rings: Include 2 or 3 reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
4. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 8 by 8 inches minimum, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 STORAGE OF MATERIALS

A. Inspect all materials delivered to the site for damage. Store materials on site in enclosures or under protective covering out of direct sunlight. Do not store materials directly on ground. Keep inside of pipes and fittings free of dirt and debris.

3.3 PIPING APPLICATIONS

A. Gravity-Flow, Nonpressure Sewer Piping: Use any of the following pipe materials for each size range:
1. NPS 3: SDR 35, sewer pipe and fittings; gaskets; and gasketed joints.
2. NPS 3: Corrugated PE drainage pipe and fittings, silttight couplings, and coupled joints.
3. NPS 3: PVC water-service pipe; PVC Schedule 40, water-service-pipe fittings; and solvent-cemented joints.
4. NPS 3: NPS 4 PVC sewer pipe and fittings; gaskets; and gasketed joints.
5. NPS 4 and NPS 6: SDR 35, sewer pipe and fittings; gaskets; and gasketed joints.
6. NPS 4 and NPS 6: Corrugated PE drainage pipe and fittings, silttight couplings, and coupled joints.
7. NPS 4 and NPS 6: Cellular-core PVC pipe, PVC sewer pipe fittings, and solvent-cemented joints.
8. NPS 4 and NPS 6: PVC sewer pipe and fittings, gaskets, and gasketed joints.
9. NPS 8 to NPS 12: Corrugated PE drainage pipe and fittings in NPS 8 and NPS 10 and corrugated PE pipe and fittings in NPS 12, silttight couplings, and coupled joints.
10. NPS 8 to NPS 12: Cellular-core PVC pipe, PVC sewer pipe fittings, and solvent-cemented joints.
11. NPS 8 to NPS 12: PVC sewer pipe and fittings, gaskets, and gasketed joints.
12. NPS 8 to NPS 12: PVC profile gravity sewer pipe and fittings, gaskets, and gasketed joints.

3.4 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install pipe in accordance with ASTM D 2321, UNI-B-5 and the following:

1. Inspect each pipe and fitting before lowering the pipe or fitting into the trench. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.
2. Use implements, tools, and facilities for the safe and proper protection of the pipe. Handle pipe in such a manner as to avoid any physical damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.
3. When installing piping in trenches, do not deviate more than 1 inch from line or 1/4 inch from grade. Measure for grade at the pipe invert.
4. Grade the bottom of the trench to the line and grade to which the pipe is to be laid, with allowance for pipe thickness. Remove hard spots that would prevent a uniform thickness of bedding. Before laying each section of the pipe, check the grade with a straightedge and correct any irregularities found. The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between bell holes, except that the grade may be disturbed for the removal of lifting tackle.
5. At the location of each joint, dig bell (joint) holes in the bottom of the trench and at the sides to permit visual inspection of the entire joint.
6. Provide and maintain means and devices at all times to remove and dispose of all water entering the trench during the process of pipelaying. The trench shall be kept dry until the pipelaying and jointing are completed. Removal of water shall be in conformance with specifications in Section 01065.
7. When the pipelaying is not in progress, including the noon hours, close the open ends of pipe. Do not permit trench water, animals, or foreign material to enter the pipe.
8. Lay pipe without break, upgrade from structure to structure, with the bell ends of the pipe upgrade.
9. Do not use the pipe as a drain for removing water that has infiltrated into the trench.
10. After joint assembly, bring the bedding material up to 1 foot above the top of the pipe. Place and compact the imported sand as directed in Section 02300. The remainder of the backfill shall be native earth backfill, installed per Section 02300.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
2. Install PE corrugated sewer piping according to CPPA's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."
3. Install PVC cellular-core piping according to ASTM D 2321 and ASTM F 1668.
4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
5. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

3.5 PIPE JOINT CONSTRUCTION

A. Apply the joint manufacturer's lubricant to the pipe spigot to assemble the joint. Follow the manufacturer's instructions. Make joints water tight and root tight.

B. Join gravity-flow, nonpressure drainage piping according to the following:
1. Join corrugated PE piping according to CPPA 100 and the following:

a. Use silttight couplings for Type 1, silttight joints.
b. Use soiltight couplings for Type 2, soiltight joints.

2. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-cement joints.
3. 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.
4. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
5. Join dissimilar pipe materials with nonpressure-type flexible or rigid couplings.

C. Join dissimilar pipe materials with pressure-type couplings.

3.6 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Install piping so cleanouts open in direction of flow in sewer pipe.

3.7 DRAIN INSTALLATION

A. Install type of drains in locations indicated.

B. Embed drains in 4-inch minimum depth of concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

E. Assemble trench sections with flanged joints.

F. Embed trench sections in 4-inch minimum concrete around bottom and sides.

3.8 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.9 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318/318R.

3.10 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 15 Section "Storm Drainage Piping."

3.11 IDENTIFICATION

A. Materials and their installation are specified in division 2 Section "Earthwork." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.12 TESTING FOR ALIGNMENT

A. After the pipe has been installed, tested for leakage, backfilled to existing grade, and manholes raised to grade and resurfaced, "ball" the pipe from manhole with a sewer scrubbing ball. After balling the pipe, perform the following:

B. "Mirror" straight sewers and inlet/outlet ends of curvilinear sewers. Perform balling and mirroring in the presence of the City's Representative to test for alignment, grade, damage or defective pipe in place, or any other type of faulty installation. Should balling and mirroring indicate any faulty installation of the pipe, repairs or replacements shall be made at the Contractor's expense.

3.13 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

    a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    b. Option: Test plastic piping according to ASTM F 1417.
    c. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.14 CLEANING

A. Clean interior of piping of dirt and superfluous materials.

3.15 CLOSEOUT DOCUMENTATION

A. Video Documentation: Upon completion of sitework, hardscaping, landscaping and pipe cleaning, televise and record on DVD storm drain piping installed as part of the Project (outside the building footprint) as follows:

1. Notify Project Inspector at least two days prior to scheduled recording.
2. Include audio narration.

B. Report: Prepare a written report of the video documentation, including the following:

1. Camera location.
2. Pipe sections being viewed.

a. Markup pipe section in conjunction with storm drain Drawings.

C. Submit DVD, written report, and Drawing markups to City in accordance with Division 1 Section "Project Closeout."

END OF SECTION 33 40 00

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SECTION 33 46 00 - SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Perforated-wall pipe and fittings.
2. Drainage conduits.
3. Drainage panels.
4. Geotextile filter fabrics.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Drainage conduits, including rated capacities.
2. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:

1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. NPS 8 and Larger: ASTM F 667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
3. Couplings: Manufacturer's standard, band type.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

2.2 DRAINAGE CONDUITS

A. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cuspated, molded-plastic drainage core wrapped in geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

2.3 SOIL MATERIALS

A. Soil materials are specified in Section 31 20 00 "Earth Moving."

2.4 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 D 4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Survivability: AASHTO M 288 Class 2.
2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 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.

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.3 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 or tape.

E. Add drainage course to top of drainage conduits.

F. After satisfactory testing, cover drainage conduit to within 12 inches of finish grade.

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.

3.4 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 D 2321.

3.5 PIPE JOINT CONSTRUCTION

A. Join perforated PE pipe and fittings with couplings according to ASTM D 3212 with loose banded, coupled, or push-on joints.

B. Join perforated PVC sewer pipe and fittings according to ASTM D 3212 with loose bell-and-spigot, push-on joints.

C. 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.

3.6 BACKWATER VALVE INSTALLATION

A. Comply with requirements for backwater valves specified in Section 33 41 00 "Storm Utility Drainage Piping."

B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.

C. Install horizontal backwater valves in piping [**in manholes or pits**] where indicated.

3.7 CLEANOUT INSTALLATION

A. Comply with requirements for cleanouts specified in Section 33 41 00 "Storm Utility Drainage Piping."

B. Cleanouts for Landscaping Subdrainage:

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 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.

3.8 CONNECTIONS

A. Comply with requirements for piping specified in Section 33 41 00 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.9 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 20 00 "Earth Moving."

1. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.10 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.

3.11 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

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ELKAY®
SPECIFICATIONS

ezH2O® Bottle Filling Station with Bi-Level Integral SwirlFlo® Fountain Filtered Refrigerated Stainless
Model LZWS-LRPBM28K

PRODUCT SPECIFICATIONS

ezH2O® Bottle Filling Station with Bi-Level Integral SwirlFlo® Fountain Filtered Refrigerated Stainless. Chilling Capacity of 8.0 GPH (gallons per hour) of 50° F drinking water, based on 80° F inlet water and 90° F ambient, per ASHRAE 18 testing. Features shall include Antimicrobial*, Filtered, Green Ticker™, Hands Free, Laminar Flow, Real Drain, Visual Filter Monitor. Furnished with Flexi-Guard ® Safety Bubbler. Electronic Bottle Filler Sensor with Mechanical Front Bubbler Button activation. Product shall be Wall Mount (Inwall Frame/Plate), for Indoor applications, serving 2 station(s). Unit shall be certified to UL 399 and CAN/CSA C22.2 No. 120.

Special Features:	Antimicrobial, Filtered, Green Ticker™, Hands Free, Laminar Flow, Real Drain, Visual Filter Monitor
Finish:	Stainless Steel
Power:	115V/60Hz
Bubbler Style:	Flexi-Guard ® Safety Bubbler
Activation by:	Electronic Bottle Filler Sensor with Mechanical Front Bubbler Button
Mounting Type:	Wall Mount (Inwall Frame/Plate)
Chilling Capacity*:	8.0 GPH
Full Load Amps	1
Rated Watts:	370
Dimensions (L x W x H):	38-1/2" x 19" x 55-1/16"
Approx. Shipping Weight:	173 lbs.
Installation Location:	Indoor
No. of Stations Served:	2
*Based on 80° F inlet water & 90° F ambient air temp for 50° F chilled drinking water.	

Special Note: Install cane apron (LKAPR1); designed for bi-level models mounted on an exposed wall.

- Mechanically-Activated unit continues to supply water in event of service disruptions.
- Visual Filter Monitor: LED Filter Status Indicator for when filter change is necessary.
- Filter is certified to NSF 42 and 53 for lead, cyst, particulate, chlorine, taste and odor reduction. 3,000 gal. capacity.
- Green Ticker: Informs user of number of 20 oz. plastic water bottles saved from waste.
- Laminar flow provides clean fill with minimal splash.
- Key plastic components are manufactured with silver ion antimicrobial agent helping to provide clean, stain- and odor-free surfaces.
- Real Drain System eliminates standing water.

PART:_____QTY: _____

PROJECT:_____

CONTACT:_____

DATE:_____

NOTES:_____

APPROVAL:_____

Included with Product: **Fountain with Integral Bottle Filling Station (LRPBD28WSC), Mounting Frame (MFWS210), Chiller (ECH8), Filter**

▼ **Ships in multiple boxes.**

A Century of Tradition and Quality.
For more than 100 years, Elkay has been making innovative products and providing exceptional customer care. We take pride in offering plumbing products that make life easier, inspire change and leave the world a better place.

PRODUCT COMPLIANCE

ADA & ICC A117.1

ASME A112.19.3/CSA B45.4

CAN/CSA C22.2 No. 120

GreenSpec®

NSF/ANSI 42, 53, 61 (Q≤1), 372 (lead free), & 401

UL 399

Complies with ADA & ICC A117.1 accessibility requirements when installed according to the requirements outlined in these standards. Installation may require additional components and/or construction features to be fully compliant. Consult the local Authority Having Jurisdiction if necessary.

Installation Instructions (PDF) - 1000003097
Installation Instructions (PDF) - 0000001030
Installation Instructions (PDF) - 0000001027

5 Year Limited Warranty on the refrigeration system of the unit. Electrical components and water system are warranted for 12 months from date of installation. **Warranty pertains to drinking water applications only. Non-drinking water applications are not covered under warranty.**

Warranty (PDF)

In keeping with our policy of continuing product improvement, Elkay reserves the right to change product specifications without notice. Please visit elkay.com for the most current version of Elkay product specification sheets. This specification describes an Elkay product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

*Antimicrobial claims are in refence to components manufactured antimicrobial agents, helping to provide clean, stain- and odor-free surfaces.

COOLING SYSTEM

- Compressor: Hermetically-sealed, reciprocating type, single phase. Sealed-in lifetime lubrication.
- Condenser: Fan cooled, copper tube with aluminum fins. Fan motor is permanently lubricated.
- Cooling Unit: Combination tube-tank type. Continuous copper tubing with is fully insulated with EPS foam that meets UL requirements for self-extinguishing material.
- Refrigerant Control: Refrigerant R-134a is controlled by accurately calibrated capillary tube.
- Temperature Control: Easily accessible enclosed adjustable thermostat is factory preset. Requires no adjustment other than for altitude requirements.

Optional Accessories		
51300C	WaterSentry® Lead + Microplastics NSF/ANSI Certified Filter (Bottle Fillers) Spec Sheet (PDF)	
WSF6000R-2PK	WaterSentry 6000 CTO Replacement Filter (2pack) Spec Sheet (PDF)	
LKAPR1	Cane Apron for SwirlFlo® Gray Spec Sheet (PDF)	
ACCESS12X38-5	Stainless Steel Access Panel for Bi-Level Architectural Fountains Spec Sheet (PDF)	

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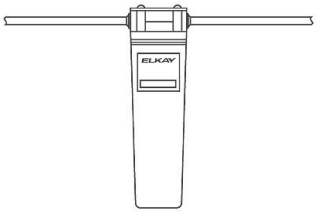
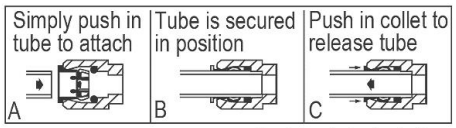
IMPORTANT!
INSTALLER PLEASE NOTE:
The grounding of electrical equipment such as telephone, computers, etc., to water lines is a common procedure. This grounding may be in the building or may occur away from the building. This grounding can cause electrical feedback into a water cooler, creating an electrolysis which causes a metallic taste or causes an increase in the metal content of the water. This condition is avoidable by using the proper materials as indicated below. The drain fittings which are provided by the installer should also be plastic to electrically isolate the cooler from the building plumbing system.



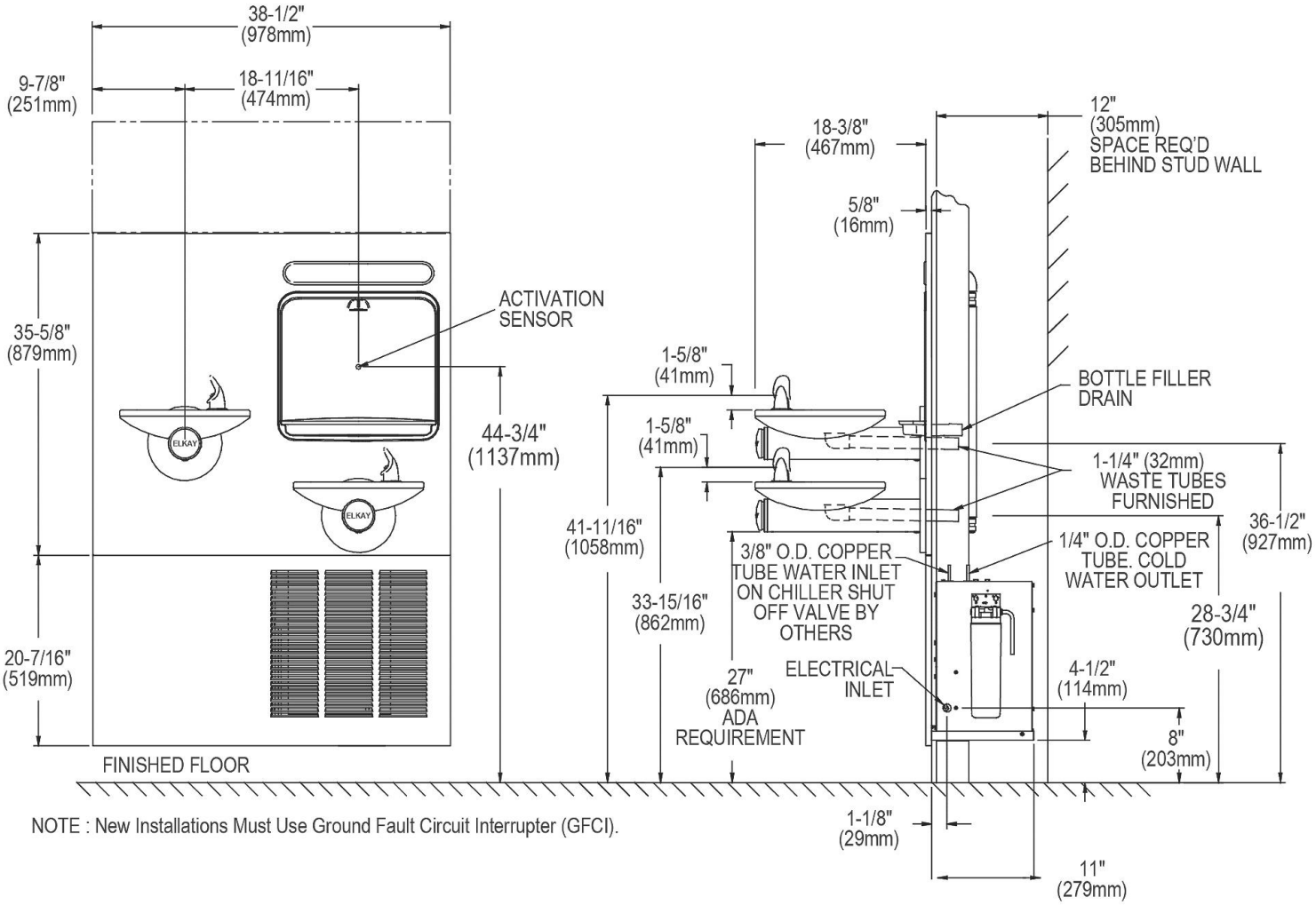
WaterSentry® Plus Filter System

OPERATION OF QUICK CONNECT FITTINGS



Pushing tube in before pulling it out helps to release tube

BOTTLE FILLER SPECIFICATIONS



NOTE : New Installations Must Use Ground Fault Circuit Interrupter (GFCI).

In keeping with our policy of continuing product improvement, Elkay reserves the right to change product specifications without notice. Please visit elkay.com for the most current version of Elkay product specification sheets. This specification describes an Elkay product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

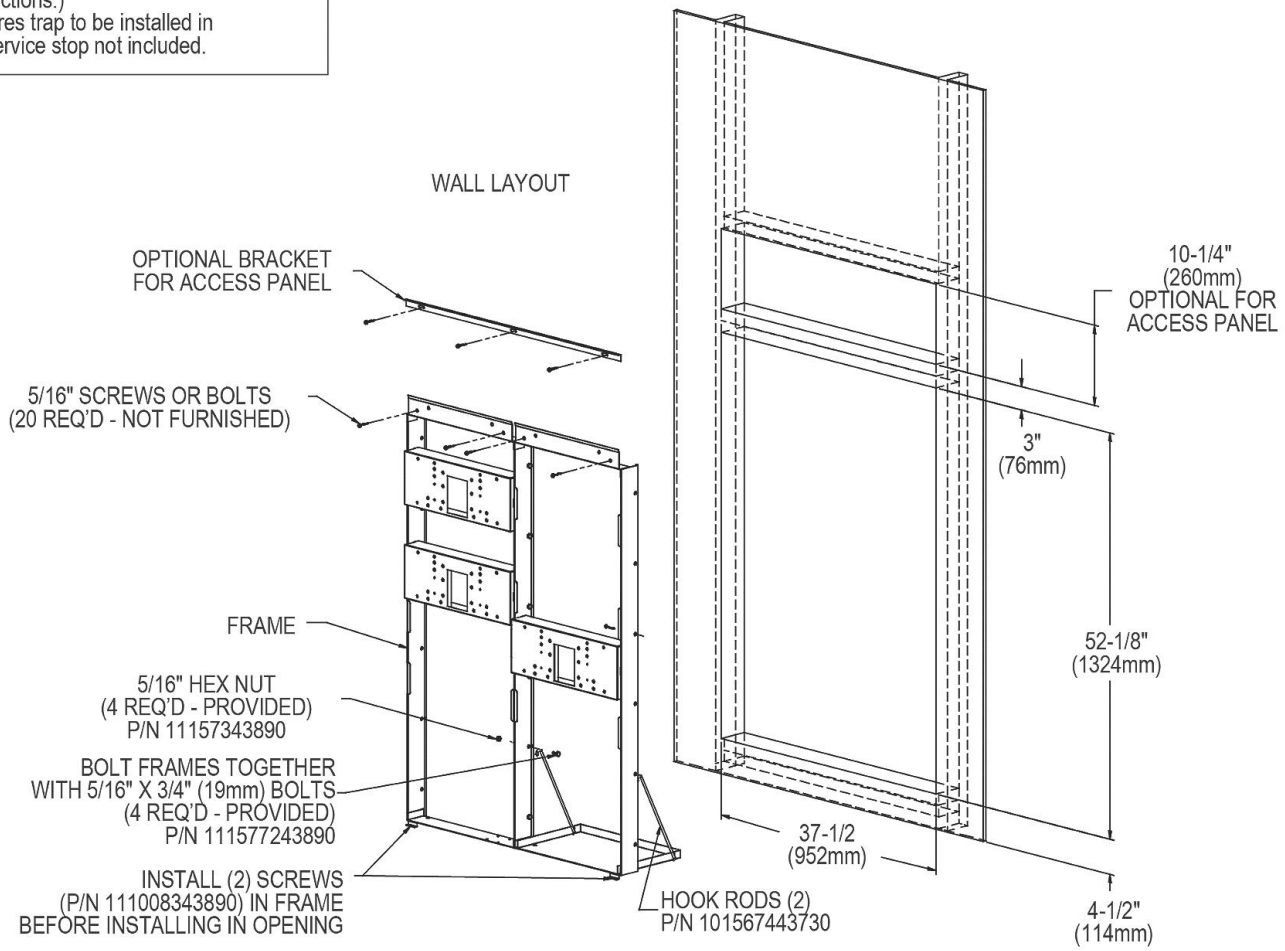
WALL OPENING
IMPORTANT: It is necessary to create a wall opening 37-1/2" W x 52-1/8" H and 4-1/2" above the floor line.
ELECTRICAL DATA
Junction box for a (3) wire 10AMP branch circuit. Standard 120 Volt, 60 HZ, single phase.
Electical outlet, three (3) conductor grounded. Locate withing safe reach of power cord.

MOUNTING FRAME MFWS210

INSTALLER NOTE
This drinking fountain is furnished with a bubbler and valve including all connecting fittings which are manufactured of completely lead free material. Shut off valve (not furnished) to accept 3/8" O.D. unplated copper tube.

MOUNTING INSTRUCTIONS
Refer to rough-in for location of plumbing and electrical sources. The support frame is to be installed first. Hang upper panel to hanger on frame. Fountains are to be attached to panel and wall frame. Water service lines, waste lines and electrical are assembled as required. Perform a final check for leaks and correct functions of fountains and chiller. (For details see the installation instructions.)
Installation requires trap to be installed in wall. Trap and service stop not included.

WALL LAYOUT



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NAMEEK'S

ML
Scarabeo 3004
Wall Mounted/Drop In Bathroom Sink

Features

- With overflow.
- Modern design.

Material

- White ceramic bathroom sink.

Installation

- Wall mount installation.
- Drop in installation.

Configurations

- Single Hole.
- Three Hole (8-inch centers).
- No Hole.

ADA

Certifications/Codes

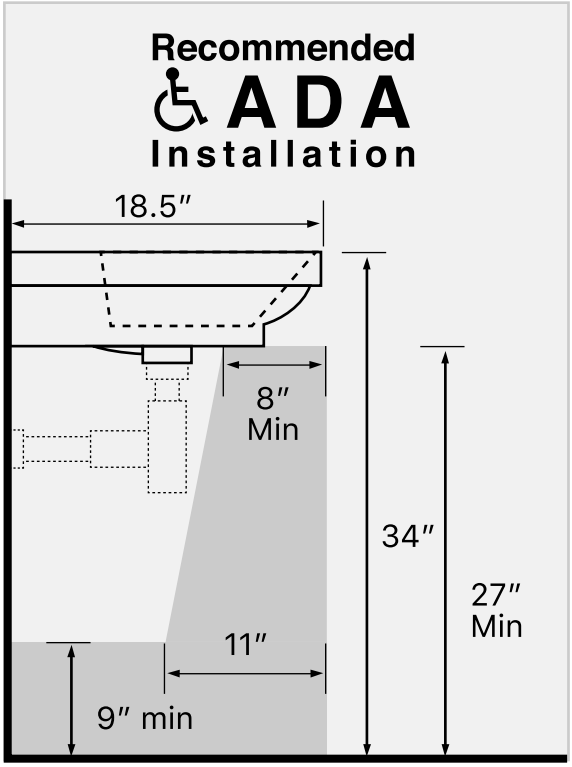
IAPMO Certified
US Standards Approved
Massachusetts Plumbing Code Approved
Uniform Plumbing Code (UPC/cUPC)
National Plumbing Code of Canada
ASME A112.19.2-2018/CSA B45.1-18

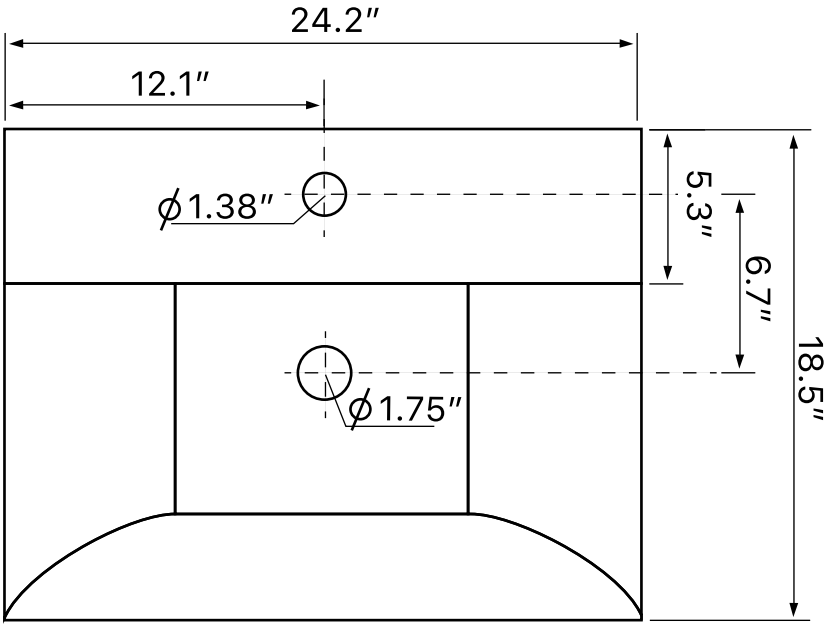
Nameek's One-Year Limited Warranty

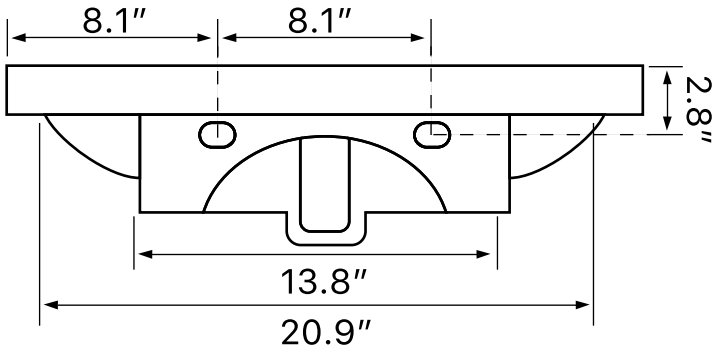
See website for warranty information details.

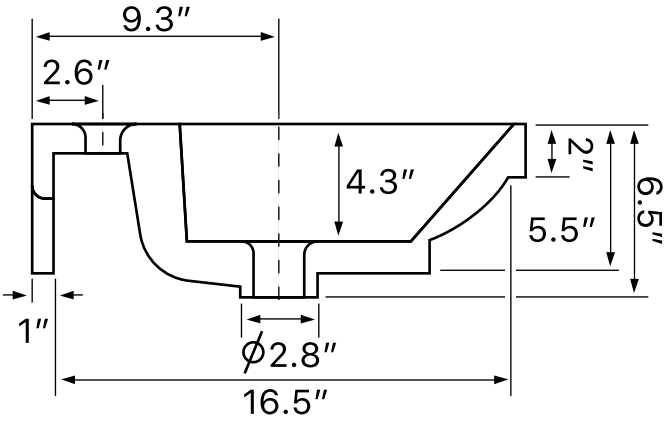
NAMEEK'S

ML
Scarabeo 3004
Wall Mounted/Drop In Bathroom Sink









Technical Information

Bowl type:	Single
Installation:	Wall mounted Drop In
Bowl dimensions:	Length: 23.5” Width: 10” Depth: 4.3”
Drain hole:	1.75”
Faucet hole:	1.38”
Hole configurations:	0, 1, 3
Weight:	40 lbs

Notes

Install this product according to the installation instructions.

ADA compliant when installed to the specific requirements of these regulations.

Includes mounting hardware.

Touchless Faucets
E80-A11H-17ABCPT

CHICAGO FAUCETS®
Geberit Group

Product Type

Advanced electronic commercial faucet with touchless sensor operation and ASSE 1070 scald protection

Features & Specifications

- Includes built-in ASSE 1070 thermostatic mixing valve (US Patent No. 11,697,929).
- 10 second run time with hand presence. Safety auto-timeout feature will shut the water off after 10 seconds. Reactivate faucet by removing hands from the sensor for at least 1 second.
- Built-in Bluetooth® technology allows for easy adjustments and mode changes using a smartphone or tablet with the Chicago Faucets CF Connect App.
- Internal Antenna Specifications: Peak Gain of the antenna: –1.7dBi, Frequency range: 2400-2500 MHz, FCC ID: 2APTX-CFC02
- Single-hole
- Vandal Proof Pressure compensating laminar flow outlet, 0.5 GPM
- E-Tronic® 80 module with Bluetooth® communication
- ECAST® design provides durable cast brass construction with total lead content equal to or less than 0.25% by weighted average
- Complies with the requirements of the Buy American Act of 1933.

Performance Specification

- Rated Operating Pressure: Operating static pressure: 20-125 PSI (138-862 kPa). Minimum static pressure for mixing 30 PSI (207 kPa). Maximum pressure differential between hot and cold water supplies: 20% x000D__x000D_ WARNING! Water temperatures in excess of 110°F (43°C) are dangerous and may cause scalding, severe injury or death! This fitting is NOT factory preset and can be adjusted to deliver water at temperatures exceeding 110°F (43°C).
- Rated Operating Temperature: Cold water inlet temperature range: 39-80°F (4-27°C). Hot water inlet temperature range: 100-180°F (38-82°C). Mixed water temperature range: up to 180°F (82°C). Adjustable temperature control. Accurate within +/- 3°F (1.7°C). Minimum flow rate for proper functioning of thermostatic protection: 0.35 GPM (1.3 LPM). Minimum inlet water supply temperature differential: 20°F (9°C).

Warranty

- 3-Year Limited Electronics and Solenoid Warranty
- Lifetime Limited Faucet Warranty
- 1-Year Limited Finish Warranty
- 5-Year Limited Mechanical Warranty

Codes & Standards

- ASME A112.18.1/CSA B125.1
- ADA ANSI/ICC A117.1
- Certified to ASSE 1070 / ASME A112.1070 / CSA B125.70
- NSF/ANSI/CAN 61: Q ≤ 1
- NSF/ANSI/CAN 372 Low Lead Content

Job Name _____

Item Number _____

Section/Tag _____

Model Specified _____

Architect _____

Engineer _____

Contractor _____

[ ] Submitted as Shown [ ] Submitted with Variations

Date _____

ECAST

ECAST products are intended for installation where state laws and local codes mandate lead content levels or in any location where lead content is a concern.

BUY AMERICAN ACT COMPLIANT

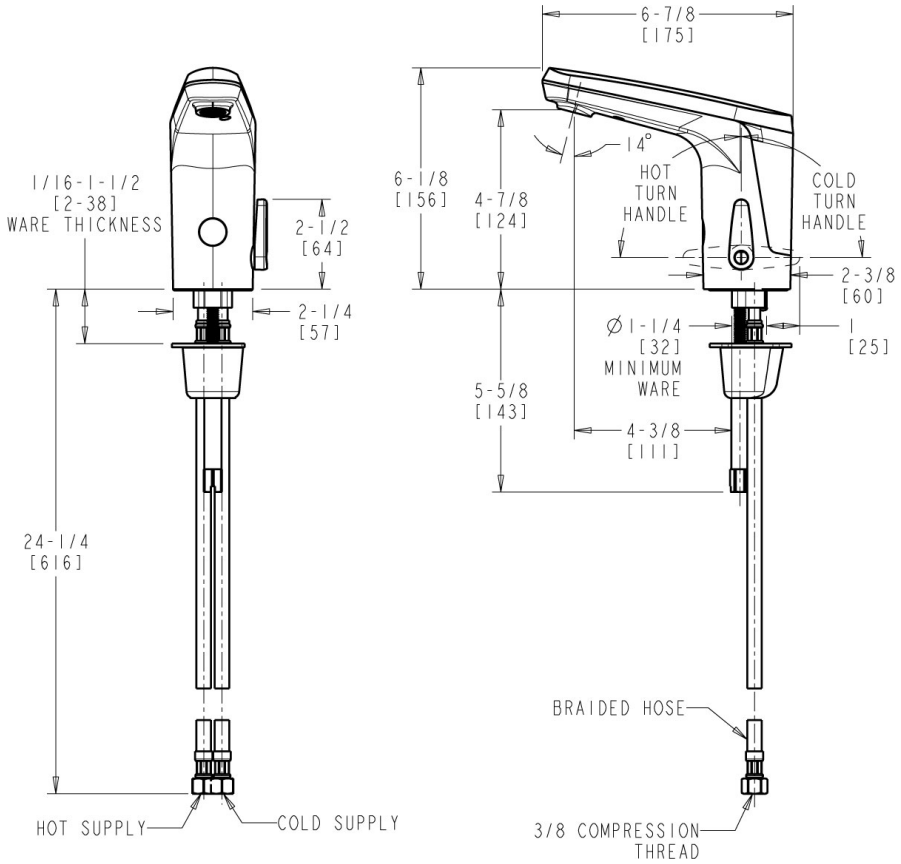
2100 South Clearwater Drive
Des Plaines, IL
P: 847/803-5000
F: 847/803-5454
Technical: 800/TEC-TRUE
www.chicagofaucets.com

E80-A11H-17ABCPT

CHICAGO FAUCETS
Geberit Group

Architect/Engineer Specification

Chicago Faucets No. E80-A11H-17ABCPT, E-Tronic® 80 faucet with dual-beam infrared sensor. Contemporary-style integral spout, chrome plated. Single-hole deck mount. 0.5 GPM (1.9 L/min) vandal-proof, pressure compensating, laminar flow outlet. Dual supply for hot and cold water service. 6-volt lithium CRP2 battery included. Flexible supply hoses included. Includes optional user-adjustable temperature control. Pre-assembled with concealed internal thermostatic mixing valve (US Patent No. 11,697,929). Multiple field-adjustable modes and ranges. Built-in Bluetooth® technology allows for easy adjustments and mode changes using a smartphone or tablet with the Chicago Faucets CF Connect App. ECAST® construction with less than 0.25% lead content by weighted average. CALGreen compliant. This product meets ADA ANSI/ICC A117.1 requirements and is tested and certified to industry standards: ASME A112.18.1/CSA B125.1, Certified to NSF/ANSI 61, Section 9, ASSE 1070, California Health and Safety Code 116875 (AB1953-2006), Vermont Bill S.152, NSF/ANSI 372 Low Lead Content, and California Green Building Standards Code (CALGreen).



Operation and Maintenance

Installation should be in accordance with local plumbing codes. Flush all pipes thoroughly before installation. After installation, remove spout outlet or flow control and flush faucet thoroughly to clear any debris. Care should be taken when cleaning the product. Do not use abrasive cleaners, chemicals or solvents as they can result in surface damage. Use mild soap and warm water for cleaning and protecting the life of Chicago Faucet products. For specific operation and maintenance refer to the installation instructions and repair parts documents that are located at www.chicagofaucets.com.

Chicago Faucets, member of the Geberit Group, is the leading brand of commercial faucets and fittings in the United States, offering a complete range of products for schools, laboratories, hospitals, office buildings, food service, airports and sport facilities. Call 1.800.TECTRUE or 1.847.803.5000 Option 1 for installation or other technical assistance.

2100 South Clearwater Drive
Des Plaines, IL
P: 847/803-5000
F: 847/803-5454
Technical: 800/TEC-TRUE
www.chicagofaucets.com

AER-DEC® AD-85000 Integrated Sink System in Corian® Dove with seamed counter spaces and baby changing area.

Seaming and Start Up Services

Ensuring your sinks look beautiful and professional

We are your go-to professional resource for hassle-free sink installation oversight and seaming service. Simplify your most complex Sloan sink installations with the help of trusted Sloan Sink Technicians. Our team can support you through your installation process right down to the final seam.

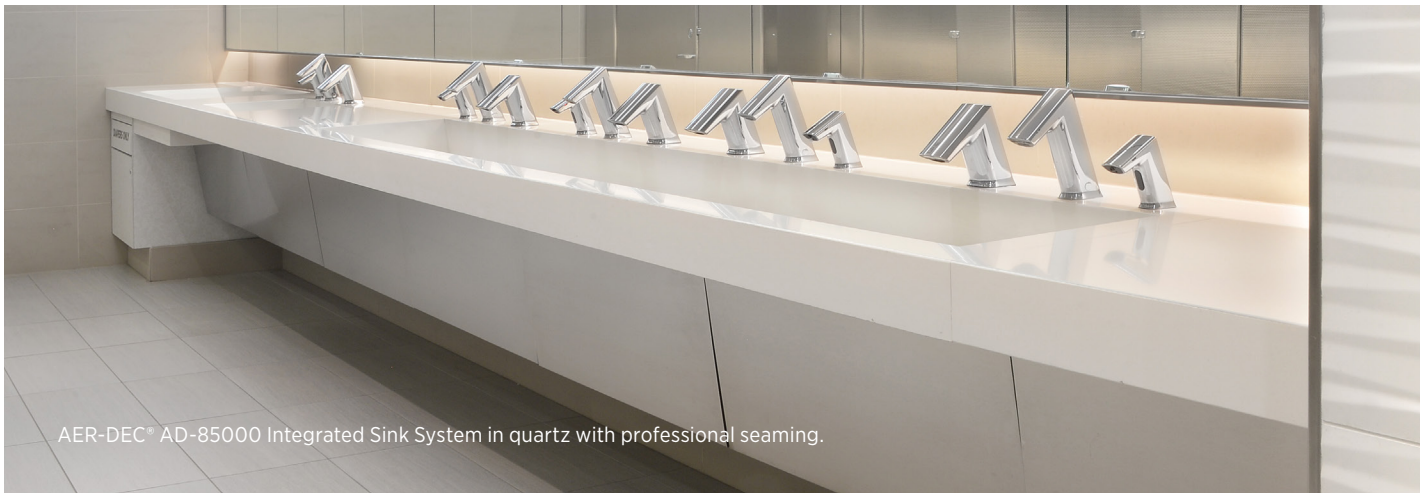
Call **844.621.7054** to inquire about Sloan Sink Seaming and Start Up Services.

Seaming Service

- Ideal for projects that require seaming service: Corian® sinks over 120″ long or quartz sinks over 119″ long
- Seaming service provided by trained Seaming Service Technicians
- Hassle-free scheduling of seaming services

Start Up Service

- Ideal projects that may benefit from start up service: large, complex, multi-sink projects
- 2-3 site visits for accurate sink installation and guidance on best practices scheduled at your convenience
- Product order delivery confirmation, order accuracy verification, and solutions for any component damage
- Sink installation inspection provided by highly qualified Sloan Application Engineer



AER-DEC® AD-85000 Integrated Sink System in quartz with professional seaming.

Sloan Seaming Service

Save time and effort on your next restroom build with sink seaming from Sloan. Sloan's approved professionals provide the high-quality finish you need to complete your vision worry-free, scheduled to fit your project timeline.

- Available for standard Corian® Solid Surface and quartz sinks over 120″ long and quartz sinks over 119″ long
- Available for custom designed sinks that require a seam under 120″ long and quartz sinks under 119″ long

What is a seam?

Sloan's sinks are custom fabricated using slabs of raw materials such as Corian Solid Surface or different brands of quartz. These slabs come in specific sizes. When the sink design or size requires that two pieces of material come together, a seam is created. Beyond slab size limitations, installers should also consider any corners the sink will need to go around to reach the restroom as well as the size of elevators or stairwells. When the sink layout or overall size requires the sink be fabricated in sections, seaming is a common installation and finishing process of joining the sink sections together creating the appearance of one continuous sink system.

How does material choice impact seaming?

Corian and other solid surface materials lend themselves beautifully to this service. When done by a professional, seams will be nearly invisible after seaming. Engineered stone materials such as quartz pose more of a challenge, but our experienced teams can minimize the appearance of any seams by blending them into the look of the sink.

Sloan Start Up Service

Our Sloan Start Up Technicians are here to guide you through the sink installation process, making sure that it is hassle-free and void of any installation errors or unforeseen product malfunction.

1. Our technician performs a site visit

We'll perform a job site walk-through and provide a thorough review of wall construction and electrical rough-ins, as well as assess the current water and drainage system.

- Review part and component order accuracy, check for sink and component damage, present installation instructions, and identify key on-site partners for the remaining visits
- Discuss installation and schedule subsequent visits
- Review seaming service plan if applicable

2. The technician oversees the installation process

Sloan technician will confirm, guide, answer questions, resolve issues. They will not performer the installation or complete any physical work.

3. Project sign-off and quality control

Our technician verifies that all components are installed as expected and functioning as intended.

- All component start up procedures, settings, and calibration documentation is provided to your maintenance staff in a maintenance guide
- The technician can answer any questions you have and provide maintenance recommendations

AER-DEC® AD-85000 Integrated Sink System in Corian® Dove with seamed counter spaces and baby changing area.

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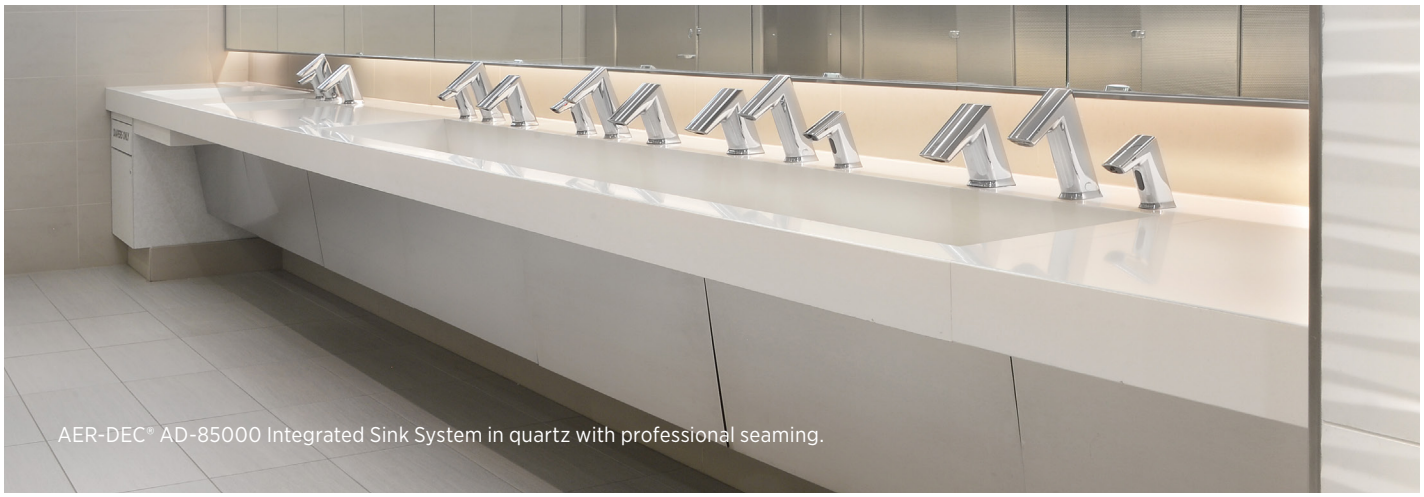

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2. The technician oversees the installation process

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Our technician verifies that all components are installed as expected and functioning as intended.

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- The technician can answer any questions you have and provide maintenance recommendations

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CUSTOMER DRIVEN SINCE 1926
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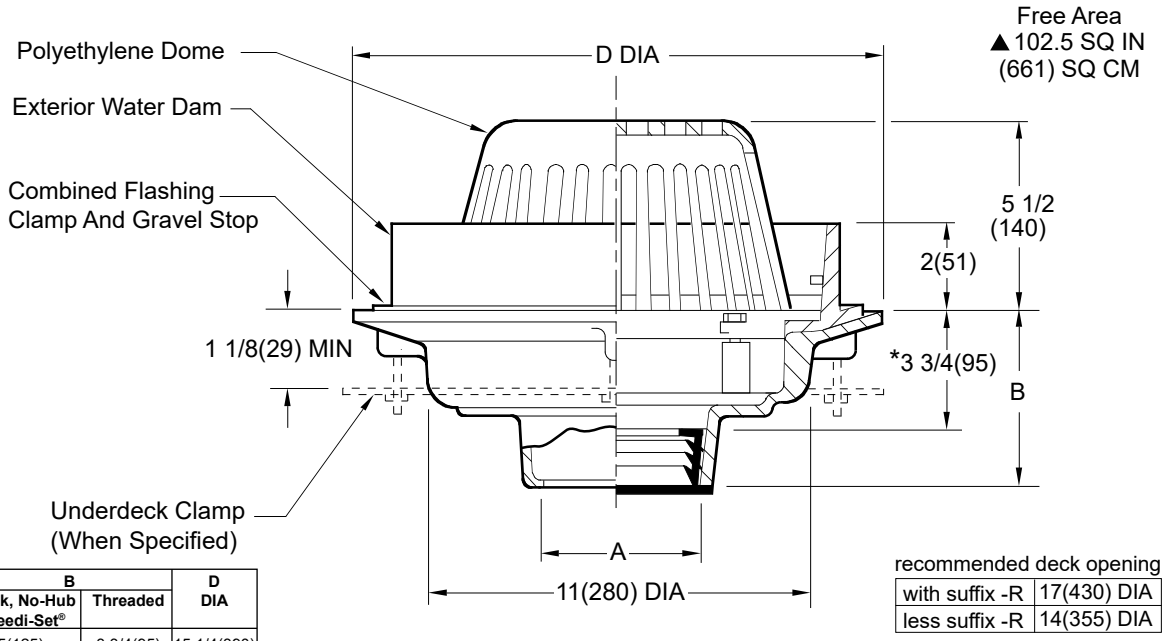
LOCATION

SPECIAL PURPOSE ROOF DRAINS

WATER DAM TYPE



A SIZE	B Caulk, No-Hub Speedi-Set®	B Threaded	D DIA
02(50), 03(75) 04(100)	5(125)	3 3/4(95)	15 1/4(390)
05(125), 06(150)	5(125)	3 3/4(95)	15 1/4(390)
08(200)-16 10(250)-16	6(150)	5(125)	16(405)

*This Dimension to Internal Stop of Speedi-Set® Gasket
NOTE: 08(200) & 10(250) outlet sizes are regularly furnished with a 20(510) dia. flange see back sheet. For 16(405) dia. flange it must be specified as -16. Ex: 1010Y08-16

recommended deck opening

with suffix -R	17(430) DIA
less suffix -R	14(355) DIA

A (Pipe Size) 02(50), 03(75), 04(100), 05(125), 06(150), 08(200)-16 or ▲10(250)-16

- [ ] **Fig. 1080C . . . . . CAULK OUTLET**
- [ ] **Fig. 1080Y . . . . . NO-HUB OUTLET**
- [ ] **Fig. 1080T . . . . . THREADED OUTLET**

REGULARLY FURNISHED:
Duco Cast Iron Body, Flashing Clamp and Gravel Stop with Polyethylene Dome, and Cast Iron Water Dam.

NOTE: Dimensions shown in parentheses are in millimeters.

▲When 10(250)-16 outlet size is specified dome height becomes 8 1/4(210) and free area of 122.5 SQ IN (790 SQ CM), furnished in cast iron and is not available in polyethylene.

VARIATIONS:
- [ ] Adjustable Extension(Specify Fig. 1045)
- [ ] Expansion Joint (Specify Fig. 1710)
- [ ] Extension -E (Specify Height)
- [ ] "L" Shaped Underdeck Clamp -CL
- [ ] L Speedi-Set® Service Weight 02(50), 03(75) & 04(100)" sizes only
- [ ] LXH Speedi-Set® Extra Heavy 02(50), 03(75) & 04(100)" sizes only
- [ ] Secondary Flashing Clamp -C2
- [✔] Sump Receiver -R
- [✔] Underdeck Clamp -C
- [✔] Vandal Proof Dome -U
- [ ] 2 1/2(64), 3(76) or 4"(100) Water Dams Available -WD025, -WD03, -WD04
- [ ] Roof Deck Plate -RDP

OPTIONAL MATERIALS:
- ▲▲ [✔] Aluminum Dome -AD
- ▲▲ [ ] Cast Iron Dome -CID
- [ ] Galvanized Cast Iron -G
- ▲▲ [ ] Galvanized Cast Iron Dome -CIDG
- ▲▲ [ ] Rough Bronze Dome -RBD

▲▲Optional domes' free area are as follows:

Aluminum	98 (632)
Cast Iron	80 (516)
Bronze	95 (613)

REV.	DATE	DESCRIPTION	BY	CKD. BY
Q	3-25-24	Revised Variations	HS	CL
P	7-18-23	Removed Function	HS	CL
N	3-8-23	Added ® to "Speedi-Set"	KK	CL
M	7-30-19	Removed NOTE	MW	CL

WEIGHT POUNDS | VOLUME CUBIC FEET

FIGURE NUMBER **1080**

DRAWING NUMBER S1080 | SIZE A | SCALE: NONE | DATE: 8-19-83 | APPROVED BY: JD | CHECKED BY: JD | DRAWN BY: CR | FIGURE NUMBER 1080

WE CAN ASSUME NO RESPONSIBILITY FOR USE OF SUPERSEDED OR VOID DATA
DIMENSIONS ARE SUBJECT TO MANUFACTURERS TOLERANCE AND CHANGE WITHOUT NOTICE

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov

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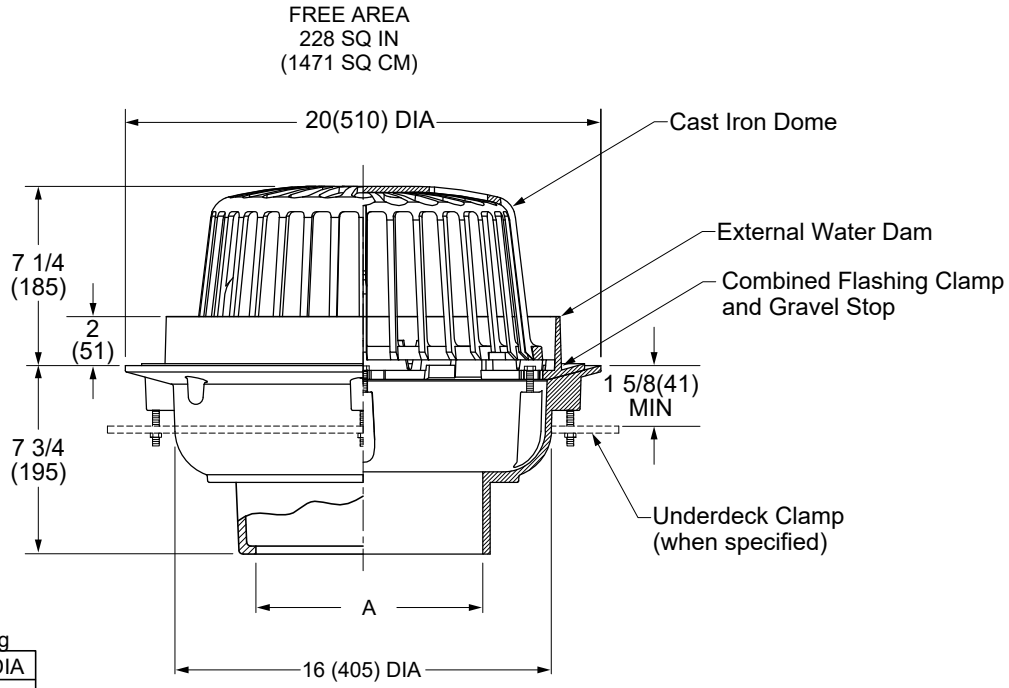
CUSTOMER DRIVEN SINCE 1926

MEMBER OF:

LOCATION

OVERFLOW ROOF DRAIN



recommended deck opening	
less suffix -R	18 3/4(475) DIA
with suffix -R	21(535) DIA

A (PIPE SIZE) = 08(200), 10(250) or *12(305)
*12(305) outlet size available in No-Hub only.

- ☐ **FIG.1080C .....CAULK OUTLET**
- ☐ **FIG.1080Y .....NO-HUB OUTLET**
- ☐ **FIG.1080T .....THREADED OUTLET**

REGULARLY FURNISHED:
Duco Cast Iron Body with External Water Dam, Combined Flashing Clamp and Gravel Stop and Cast Iron Dome.

VARIATIONS:
- ☐ Extension (Specify Height) -E
- ☐ Secondary Flashing Clamp -C2
- ☐ Sump Receiver -R
- ☐ Underdeck Clamp -C
- ☐ "L" Shaped Underdeck Clamp -CL
- ☐ Vandal Proof Dome -U
- ☐ Stainless Steel Mesh Over Dome-SSM
- ☐ Roof Deck Plate -RDP

OPTIONAL MATERIALS:
- ☐ Aluminum Dome -AD
- ☐ Galvanized Cast Iron -G
- ☐ Galvanized Cast Iron Dome Only -CIDG

REV.	DATE	DESCRIPTION	BY	CKD. BY
D	3-25-24	Revised Variations	HS	CL
C	7-18-23	Removed Function, Changed B.S.	HS	CL
B	7-30-19	Removed NOTE	MW	CL
A	10-28-15	Added Flow Rate Note	TBW	BW

WEIGHT POUNDS

VOLUME CUBIC FEET

FIGURE NUMBER **1080(Back Sheet)**

FIGURE NUMBER **1080(Back Sheet)**

DRAWN BY: TBW | CHECKED BY: CL | APPROVED BY: CL | DATE: 3-13-13 | SCALE: NONE | SIZE A | DRAWING NUMBER S1080(BackSheet) | D

DIMENSIONS ARE SUBJECT TO MANUFACTURERS TOLERANCE AND CHANGE WITHOUT NOTICE
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WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov

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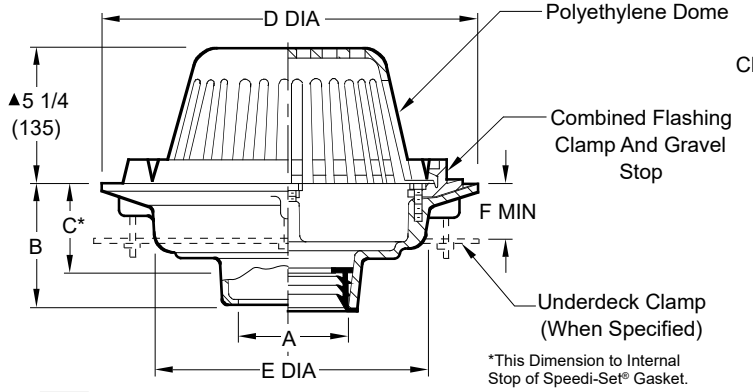
CUSTOMER DRIVEN SINCE 1926

MEMBER OF:

LOCATION

LARGE GENERAL PURPOSE ROOF DRAINS

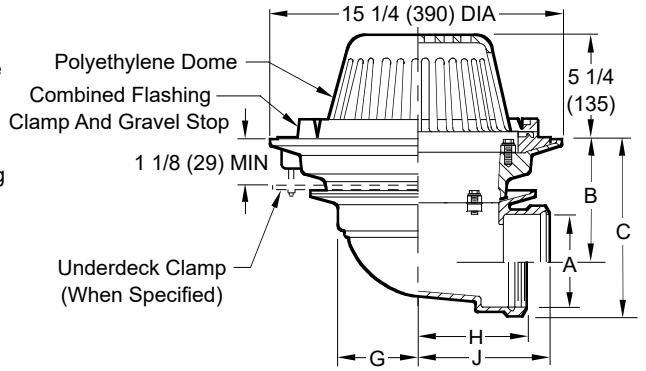
LOW PROFILE DOME



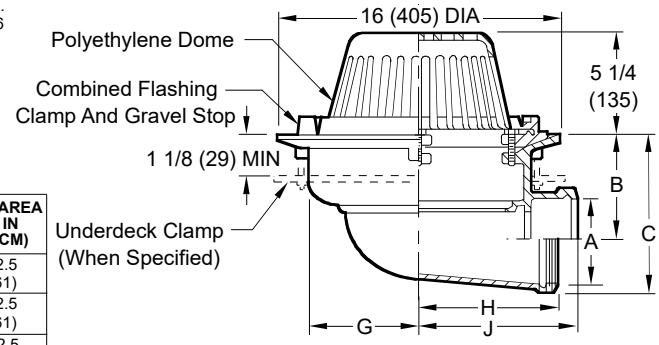
*This Dimension to Internal Stop of Speedi-Set® Gasket.

**NOTE: 08(200) & 10(250) outlet sizes are regularly furnished with 20(510) dia. flange, see back sheet. If 16(405) dia. flange is required -16 MUST be specified. Ex: 1010Y08-16 or 1010Y10-16

☐ Fig. 1010C . . . .CAULK OUTLET
☐ Fig. 1010Y . . . .NO-HUB OUTLET
☐ Fig. 1010T . . . .THREADED OUTLET



☐ Fig. 1020C 02(50), 03(75) & 04(100)" CAULK OUTLET
☐ Fig. 1020T 02(50), 03(75) & 04(100)" THREADED OUTLET



☐ Fig. 1020C 05(125) & 06"(150) CAULK OUTLET
☐ Fig. 1020T 05(125) & 06"(150) THREADED OUTLET

recommended deck opening

outlet size	with suffix-R	less suffix-R
02(50),03(75),04(100) 05(125),06(150)	17(430) DIA	14(355) DIA
**08(200)-16, **10(250)-16	17(430) DIA	14 3/4 (375) DIA

A SIZE	B (BOTTOM OUTLET)						SIDE OUTLET			FREE AREA SQ IN (SQ CM)
	CAULK, NO-HUB, & SPEEDI-SET®	THREADED	C	D DIA	E DIA	F MIN	G	H	J	
02(50)	5 (125)	3 3/4 (95)	3 3/4 (95)	15 1/4 (390)	11 (280)	1 1/8 (29)	4 3/4 (120)	6 (150)	10 (254)	102.5 (661)
03(75)	5 (125)	3 3/4 (95)	3 3/4 (95)	15 1/4 (390)	11 (280)	1 1/8 (29)	4 3/4 (120)	6 (150)	9 3/4 (248)	102.5 (661)
04(100)	5 (125)	3 3/4 (95)	3 3/4 (95)	15 1/4 (390)	11 (280)	1 1/8 (29)	4 3/4 (120)	6 (150)	9 5/8 (244)	102.5 (661)
05(125)	5 (125)	3 3/4 (95)	--	15 1/4 (390)	11 (280)	1 1/8 (29)	6 1/4 (160)	6 7/8 (175)	10 (254)	102.5 (661)
06(150)	5 (125)	3 3/4 (95)	--	15 1/4 (390)	11 (280)	1 1/8 (29)	6 1/4 (160)	6 7/8 (175)	7 3/4 (195)	102.5 (661)
**08(200)-16, **10(250)-16	6 (150)	5 (125)	--	16 (405)	12 1/2 (320)	1 1/8 (29)	--	--	--	102.5(661) ▲122.5(790)

(SIDE OUTLET)

A SIZE	02 (50)	03 (75)	04 (100)	05 (125)	06 (150)
B	6 7/8 (175)	6 3/8 (162)	5 7/8 (149)	5 (125)	4 1/2 (115)
C	8 5/8 (219)	8 3/4 (220)	8 3/4 (220)	8 1/2 (215)	8 1/2 (215)

REGULARLY FURNISHED:
Duco Cast Iron Body with Combined Flashing Clamp and Gravel Stop with Polyethylene Dome.

▲**NOTE:** The dome height is 8 1/4" (210) for the 122.5 SQ IN free area dome and is regularly furnished in Cast Iron and is not available in polyethylene.

NOTE: Dimensions shown in parentheses are in millimeters.

VARIATIONS:
- ☐ Expansion Joint (Specify Fig. 1710) (Fig. 1010 only)
- ☐ Extension (Specify Height) -E
- ☐ "L" Shaped Underdeck Clamp -CL
- ☐ L Speedi-Set® Service Weight 02(50), 03(75) and 04(100)" sizes only (Fig. 1010 0nly)
- ☐ LXH Speedi-Set® Extra Heavy 02(50), 03(75) and 04(100)" sizes only (Fig. 1010 only)
- ☐ NO-HUB Adaptor (Specify Fig. 2646Y) (Fig. 1020 only)
- ☐ Secondary Flashing Clamp -C2
- ✔ Sump Receiver -R
- ✔ Underdeck Clamp -C
- ✔ Vandal Proof Dome -U
- ☐ Stainless Steel Mesh Over Dome -SSM
- ☐ Roof Deck Plate -RDP

OPTIONAL MATERIALS:
- ☐ ▲▲Aluminum Dome -AD
- ☐ ▲▲Cast Iron Dome -CID
- ☐ ▲▲Galvanized Cast Iron Dome -CIDG
- ☐ Galvanized Cast Iron Body & Collar -G
- ☐ ▲▲Rough Bronze Dome -RBD
- ☐ Stainless Steel (Specify Fig. 9780)

▲▲Optional Domes' free area are as follows:

Dome Mat'l	02-06 & 08-16 Outlets
Aluminum	98 (632)
Cast Iron	80 (516)
Bronze	95 (613)

REV.	DATE	DESCRIPTION	BY	CKD. BY
AB	9-20-24	Revised Table	HS	CL
AA	3-25-24	Revised Variations, Fig Opts.	HS	CL
Z	2-8-24	Revised Optional Materials	HS	CL
Y	7-18-23	Removed Function	HS	CL

WEIGHT POUNDS | VOLUME CUBIC FEET

FIGURE NUMBER **1010, 1020**

AB | DRAWING NUMBER S1010 | SIZE A | SCALE: NONE | DATE: 5-24-85 | APPROVED BY: TD | CHECKED BY: TD | DRAWN BY: CR | FIGURE NUMBER 1010, 1020

WE CAN ASSUME NO RESPONSIBILITY FOR USE OF SUPERSEDED OR VOID DATA

DIMENSIONS ARE SUBJECT TO MANUFACTURERS TOLERANCE AND CHANGE WITHOUT NOTICE

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov

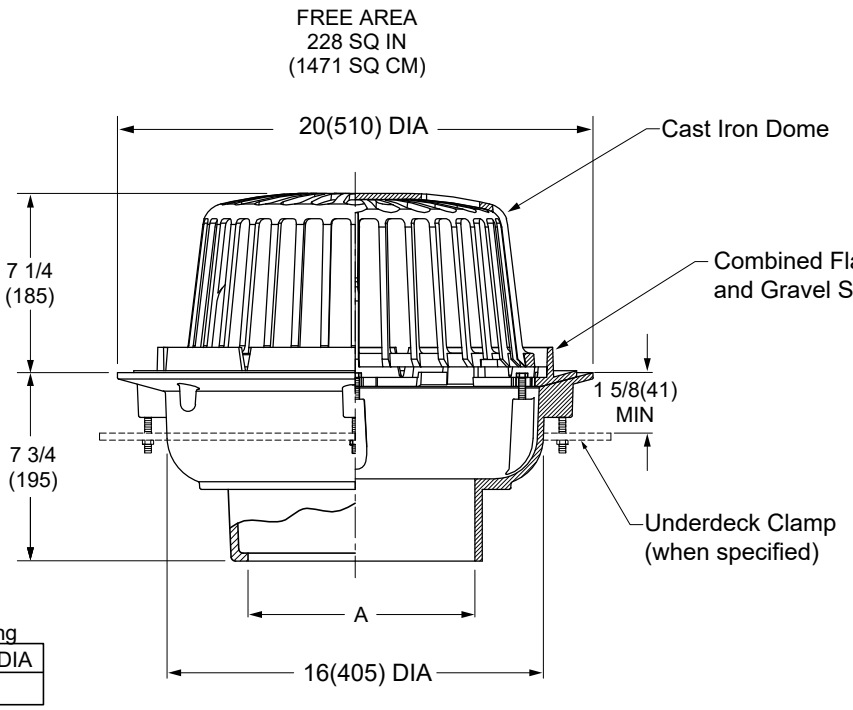
SMITH® JAY R. SMITH MFG. CO.®
MEMBER OF MORRIS GROUP INTERNATIONAL
POST OFFICE BOX 3237
MONTGOMERY, ALABAMA 36109-0237 (USA)
TEL: 334-277-8520 FAX: 888-377-7818 www.jrsmith.com

CUSTOMER DRIVEN SINCE 1926

MEMBER OF:

LOCATION

LARGE GENERAL PURPOSE ROOF DRAIN



recommended deck opening	
less suffix -R	18 3/4(475) DIA
with suffix -R	21(535) DIA

A (PIPE SIZE) = 08(200), 10(250) or *12(305)
*12(305) outlet size available in No-Hub only.

- [ ] FIG.1010C .....CAULK OUTLET
- [x] FIG.1010Y .....NO-HUB OUTLET
- [ ] FIG.1010T .....THREADED OUTLET

REGULARLY FURNISHED:
Duco Cast Iron Body with Combined Flashing Clamp and Gravel Stop and Cast Iron Dome.

VARIATIONS:
- [ ] Extension (Specify Height) -E
- [ ] Secondary Flashing Clamp -C2
- [x] Sump Receiver -R
- [x] Underdeck Clamp -C
- [ ] "L" Shaped Underdeck Clamp -CL
- [x] Vandal Proof Dome -U
- [ ] Stainless Steel Mesh Over Dome -SSM
- [ ] Roof Deck Plate -RDP

OPTIONAL MATERIALS:
- [x] Aluminum Dome -AD
- [ ] Galvanized Cast Iron -G
- [ ] Galvanized Cast Iron Dome Only -CIDG

NOTE: Dimensions shown in parentheses are in millimeters.

REV.	DATE	DESCRIPTION	BY	CKD. BY
D	3-25-24	Revised Variations	HS	CL
C	7-18-23	Removed Fuction, Changed B.S.	HS	CL
B	7-30-19	Removed NOTE	MW	CL
A	8-3-15	Added Flow Rate Note	TBW	BW

WEIGHT POUNDS | VOLUME CUBIC FEET

FIGURE NUMBER **1010(Back Sheet)**

DRAWING NUMBER S1010(BackSheet) | SIZE A | SCALE: NONE | DATE: 3-13-13 | APPROVED BY: CL | CHECKED BY: CL | DRAWN BY: TBW | FIGURE NUMBER 1010(Back Sheet) | D

WE CAN ASSUME NO RESPONSIBILITY FOR USE OF SUPERSEDED OR VOID DATA
DIMENSIONS ARE SUBJECT TO MANUFACTURERS TOLERANCE AND CHANGE WITHOUT NOTICE

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov

American Standard
Style That Works Better

FLORWELL™ SERVICE SINK
ENAMELED CAST IRON

FLORWELL™ SERVICE SINK

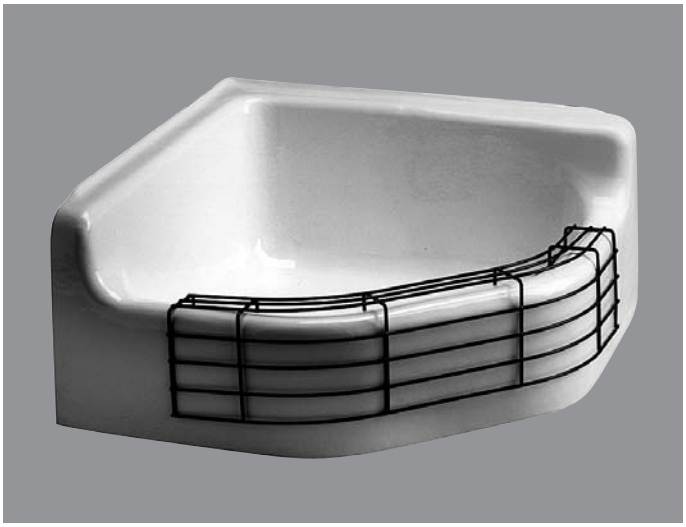
- Enameled cast iron
- 3" outlet
- Corner model

❑ **7741.000** Fixture only - Less rim guard

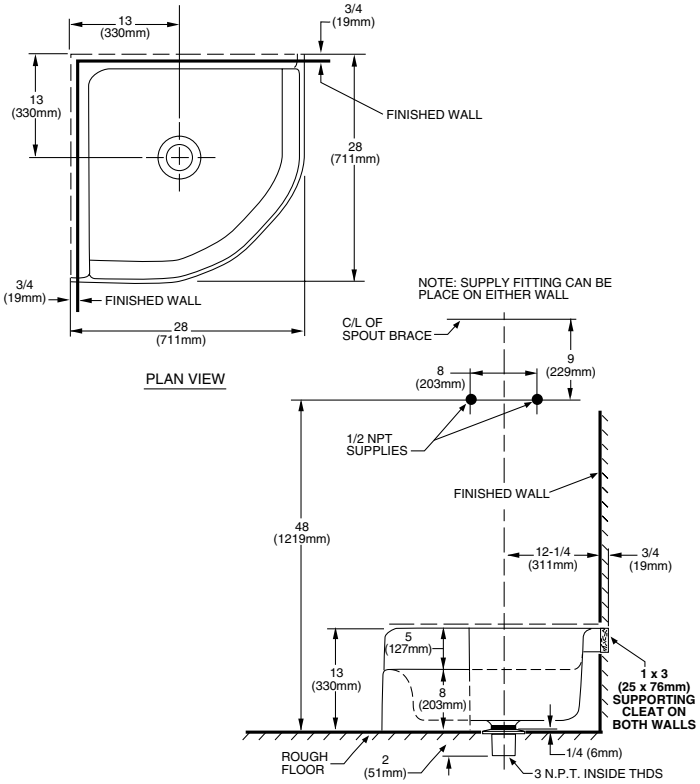
❑ **7745.811** Removable vinyl rim guard

Nominal Dimensions:
711 x 711 x 330mm
(28" x 28" x 13")

Compliance Certifications -
Meets or Exceeds the Following Specifications:
• ASME A112.19.1 for Cast Iron Plumbing Fixtures



To Be Specified:
❑ Faucet: 8344.112 faucet with top brace, stops, and vacuum breaker
❑ Alternative Faucet:
❑ Drain: 7721.038 flat grid drain
❑ Removable vinyl-coated rim guard: 7745.811 (black)



NOTES:
PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORTS.
FITTINGS NOT INCLUDED AND MUST BE ORDERED SEPARATELY.

IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.

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Manual Sink Faucets
897-CP

CHICAGO FAUCETS®
Geberit Group

Product Type

Wall-mounted manual faucet with 8" centers

Features & Specifications

- Handles include color-coded index
- Integral supply stops
- 8" body, adjustable arms 7-5/8" - 8-3/8" centers
- Vandal Proof 2-3/8" Lever handle (pair)
- Ceramic 1/4-turn operating cartridge, right-hand
- Ceramic 1/4-turn operating cartridge, left-hand
- Arm, 3/16" offset
- Vacuum breaker assembly
- Complies with the requirements of the Buy American Act of 1933.
- CFNow! Item Ships in 3 Days

Performance Specification

- Rated Operating Pressure: 20-125 PSI
- Rated Operating Temperature: 40-140°F

Warranty

- 5-Year Limited Cartridge Warranty
- Lifetime Limited Faucet Warranty
- 1-Year Limited Finish Warranty

Codes & Standards

- ASME A112.18.1/CSA B125.1
- ADA ANSI/ICC A117.1
- ASSE 1001 Compliant

Job Name _____

Item Number _____

Section/Tag _____

Model Specified _____

Architect _____

Engineer _____

Contractor _____

[ ] Submitted as Shown [ ] Submitted with Variations

Date _____

BUY AMERICAN ACT COMPLIANT

BUILD AMERICA BABA BUY AMERICA

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Des Plaines, IL
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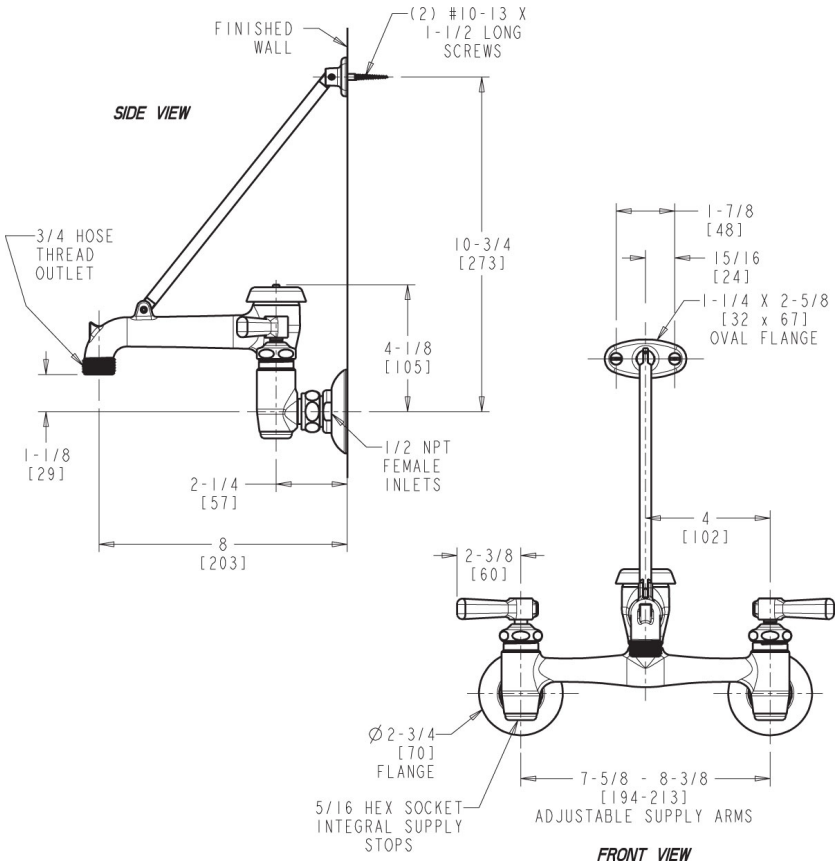
Technical: 800/TEC-TRUE
www.chicagofaucets.com

897-CP

CHICAGO FAUCETS
Geberit Group

Architect/Engineer Specification

Chicago Faucets No. 897-CP, Sink Faucet for hot and cold water, wall-mounted with 7-5/8" - 8-3/8" adjustable centers. Body and spout made of durable cast brass with polished chrome finish. Vacuum breaker spout with pail hook and wall brace. 2-3/8" metal, vandal-proof, lever handles with sixteen-point, tapered broach and secured blue and red index buttons. Ceramic 1/4-turn operating cartridge, opens and closes 90°, closes with water pressure, features square, tapered stem. Adjustable supply arms include 1/2" NPT female union nut. 3/4" male hose thread outlet. Integral stop valves for servicing the faucet. NOTE: Atmospheric vacuum breaker is NOT intended for continuous pressure applications. This product meets ADA ANSI/ICC A117.1 requirements and is tested and certified to industry standards: ASME A112.18.1/CSA B125.1.



Operation and Maintenance

Installation should be in accordance with local plumbing codes. Flush all pipes thoroughly before installation. After installation, remove spout outlet or flow control and flush faucet thoroughly to clear any debris. Care should be taken when cleaning the product. Do not use abrasive cleaners, chemicals or solvents as they can result in surface damage. Use mild soap and warm water for cleaning and protecting the life of Chicago Faucet products. For specific operation and maintenance refer to the installation instructions and repair parts documents that are located at www.chicagofaucets.com.

Chicago Faucets, member of the Geberit Group, is the leading brand of commercial faucets and fittings in the United States, offering a complete range of products for schools, laboratories, hospitals, office buildings, food service, airports and sport facilities. Call 1.800.TECTRUE or 1.847.803.5000 Option 1 for installation or other technical assistance.

2100 South Clearwater Drive
Des Plaines, IL
P: 847/803-5000
F: 847/803-5454
Technical: 800/TEC-TRUE
www.chicagofaucets.com

Just manufacturing

SPECIFICATIONS

Stainless Steel 15" x 17-1/2" x 5" Single Bowl Drop-in ADA Sink

Model(s) SLADA1815A50-J

PRODUCT SPECIFICATIONS

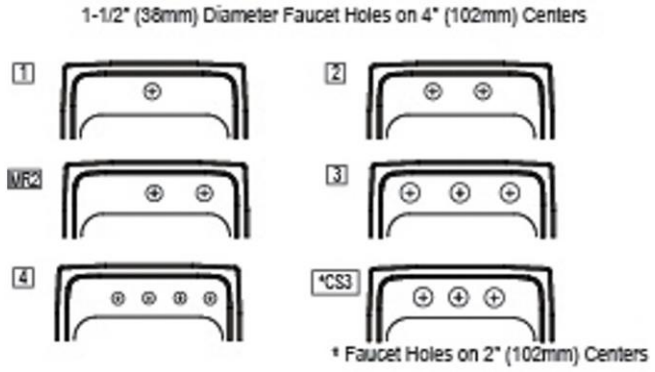
Stainless Steel 15" x 17-1/2" x 5" Single Bowl Drop-in ADA Sink. Sink is manufactured from 18 gauge 304 Stainless Steel with a Lustrous Satin finish, Center drain placement, and Bottom only pads.

Installation Type:	Drop-in
Material:	304 Stainless Steel
Finish:	Lustrous Satin
Gauge:	18
Sound Deadening:	Bottom only pads
Number of Bowls:	1
Sink Dimensions:	15" x 17-1/2" x 5"
Bowl 1 Dimensions:	12" x 12" x 5"
Drain Size:	3-1/2" (89mm)
Drain Location:	Center
Minimum Cabinet Size:	18"
Mounting Hardware:	Included
Cutout Template #:	1000001273

Template is available for download at justmfg.com. CAD software will be required to open the template.

Cutout Dimensions for Drop-in Installation:
14-3/8" x 16-7/8" (365mm x 429mm) with 1-1/2" (38mm) corner radius

Hole Drilling Configurations:



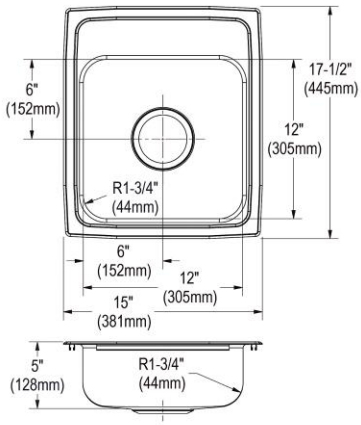
Quality Grade Plumbing Products.
Since 1933 we have become the industry standard for designing and producing quality grade plumbing products and fixtures. Our role as an industry leader remains unsurpassed.

Product Compliance: ASME A112.19.3/CSA B45.4
ADA & ICC A117.1

Sinks are listed by IAPMO® as meeting the applicable requirements of the Uniform Plumbing Code®, International Plumbing Code®, and National Plumbing Code of Canada.

Complies with ADA & ICC A117.1 accessibility requirements when installed according to the requirements outlined in these standards.

Clean and Care Manual (PDF)
Installation Instructions (PDF) - 20000000856
Warranty (PDF)



PART:_____QTY: _____

PROJECT:_____

CONTACT:_____

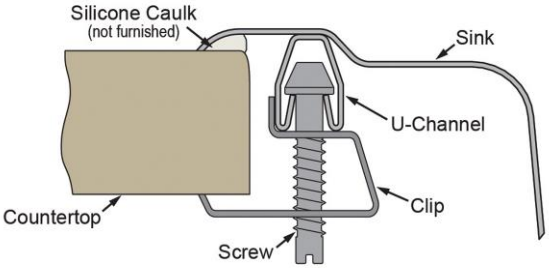
DATE:_____

NOTES:_____

APPROVAL:_____

In keeping with our policy of continuing product improvement, Just Mfg reserves the right to change product specifications without notice. Please visit justmfg.com for the most current version of Just Mfg product specification sheets. This specification describes a product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

Installation Profile:



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Manual Sink Faucets
2302-E35ABCP

CHICAGO FAUCETS®
Geberit Group

Product Type

Deck-mounted manual faucet, two-hole mounting

Features & Specifications

- Single-hole with side valve
- 5-1/4" Rigid/swing gooseneck spout
- Pressure compensating Softflo aerator, 1.5 GPM
- 2-3/4" Lever handle
- Ceramic operating cartridge with volume control and hot water limit stop
- ECAST® design provides durable cast brass construction with total lead content equal to or less than 0.25% by weighted average
- Complies with the requirements of the Buy American Act of 1933.

Performance Specification

- Rated Operating Pressure: 20-125 PSI
- Rated Operating Temperature: 40-140°F

Warranty

- 5-Year Limited Cartridge Warranty
- Lifetime Limited Faucet Warranty
- 1-Year Limited Finish Warranty

Codes & Standards

- ASME A112.18.1/CSA B125.1
- ADA ANSI/ICC A117.1
- Complies with CALGreen requirements
- NSF/ANSI/CAN 372 Low Lead Content
- NSF/ANSI/CAN 61: Q ≤ 1
- Certified to WaterSense by ICC-ES

Job Name _____

Item Number _____

Section/Tag _____

Model Specified _____

Architect _____

Engineer _____

Contractor _____

[ ] Submitted as Shown [ ] Submitted with Variations

Date _____

ECAST

ECAST products are intended for installation where state laws and local codes mandate lead content levels or in any location where lead content is a concern.

BUY AMERICAN ACT COMPLIANT

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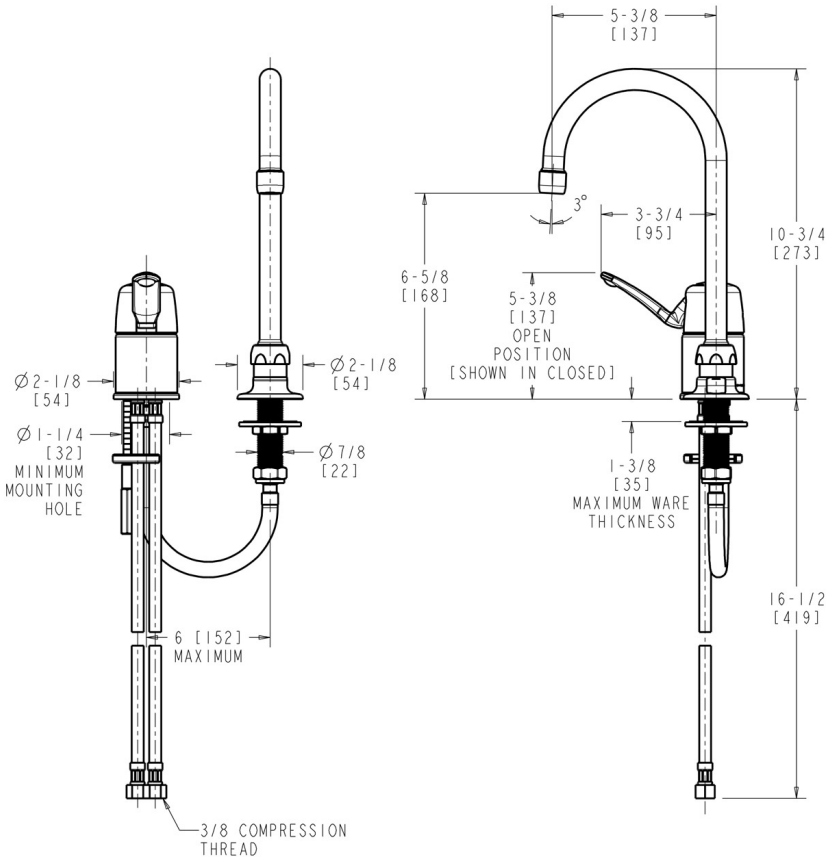
www.chicagofaucets.com

2302-E35ABCP

CHICAGO FAUCETS
Geberit Group

Architect/Engineer Specification

Chicago Faucets No. 2302-E35ABCP, Sink Faucet for hot and cold water, single lever, two-hole deck mount with side valve, chrome plated. Rigid/swing gooseneck spout, 5-1/4" center-to-center. 1.5 GPM (5.7 L/min) pressure compensating Softflo aerator. 4-5/8" metal lever handle with blue-and-red temperature indicator. Ceramic quarter-turn cartridge, features square, tapered stem. Flexible supply hoses with 3/8" compression fitting. ECAST® construction with less than 0.25% lead content by weighted average. CALGreen compliant. This product meets ADA ANSI/ICC A117.1 requirements and is tested and certified to industry standards: ASME A112.18.1/CSA B125.1, Certified to NSF/ANSI 61, Section 9, California Health and Safety Code 116875 (AB1953-2006), Vermont Bill S.152, NSF/ANSI 372 Low Lead Content, and California Green Building Standards Code (CALGreen).



Operation and Maintenance

Installation should be in accordance with local plumbing codes. Flush all pipes thoroughly before installation. After installation, remove spout outlet or flow control and flush faucet thoroughly to clear any debris. Care should be taken when cleaning the product. Do not use abrasive cleaners, chemicals or solvents as they can result in surface damage. Use mild soap and warm water for cleaning and protecting the life of Chicago Faucet products. For specific operation and maintenance refer to the installation instructions and repair parts documents that are located at www.chicagofaucets.com.

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Greenbrook® Urinal

VITREOUS CHINA

BARRIER FREE

Greenbrook® Urinal

- Highly aesthetic vitreous china urinal with large footprint
- Urinal has optimized surface contours and water flushing spreader that rinses inverted back wall for superior splash protection
- High Efficiency Urinal (HEU) operates in the range of 0.125 gpf to 0.5 gpf (0.47 Lpf to 1.9 Lpf)
- 3/4" (19 mm) inlet spud with 2" (51 mm) outlet spud
- Permanent EverClean® surface inhibits the growth of stain and odor causing bacteria
- Includes removable strainer and two wall hangers

❏ **6516001EC** Greenbrook top spud

❏ **6517001EC** Greenbrook back spud

Nominal Dimensions:
15" x 16-1/8" x 27-1/2"
(380 x 411 x 698mm)

Recommended working pressure – between 20 psi at valve when flushing and 80 psi static

Compliance Certifications -
Meets or Exceeds the Following Specifications:
- ASME A112.19.2/CSA B45.1 for Vitreous China Fixtures

6516001EC Top Spud

To Be Specified:
❏ Color: ❏ White
❏ Flush Valve:

0.5 gpf Flush Valve: Sensor-Operated:
- ❏ American Standard Selectronic® #6063051.002 DC Power (Top Spud)
- ❏ American Standard Selectronic® #606B305.007 AC Power (Back Spud)

0.5 gpf Flush Valve: Manual-Operated:
- ❏ American Standard #6045051.002

0.125 gpf Flush Valve: Sensor-Operated:
- ❏ American Standard Selectronic® #6063013.002 DC Power (Top Spud)
- ❏ American Standard Selectronic® #606B301.007 AC Power (Back Spud)

0.125 gpf Flush Valve: Manual-Operated:
- ❏ American Standard #6045013.002

6517001EC Back Spud

SEE REVERSE FOR ROUGHING-IN DIMENSIONS

MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES AND ANSI A117.1 ACCESSIBLE AND USABLE BUILDINGS AND FACILITIES - CHECK LOCAL CODES.
- When installed so top of rim is 432mm (17") MAXIMUM from finished floor.

EVERCLEAN® | CEC WHEN USED WITH 0.125 gpf urinal flush valve | WHEN USED WITH 0.125 gpf or 0.5 gpf urinal flush valves | ADA COMPLIANT

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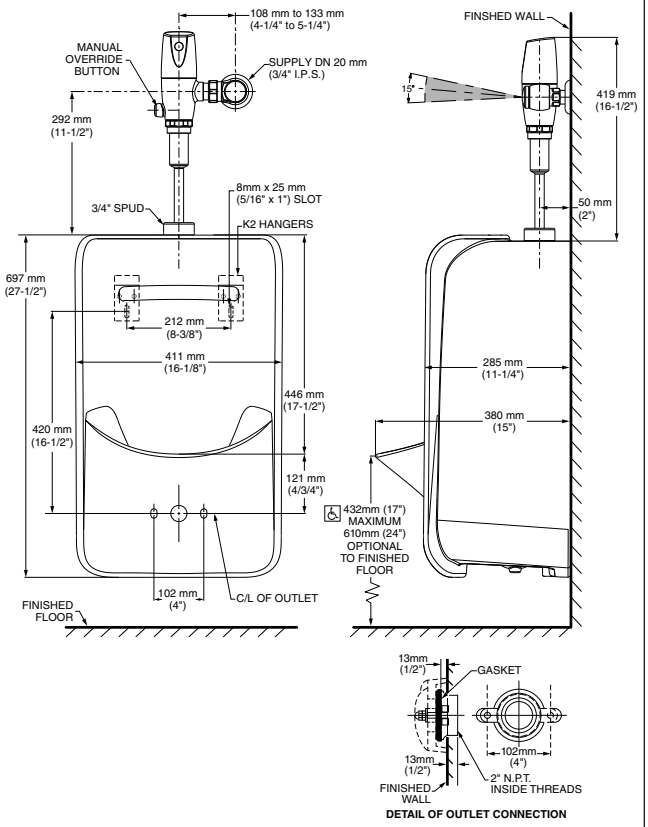
PART OF LIXIL

Greenbrook® Urinal

VITREOUS CHINA

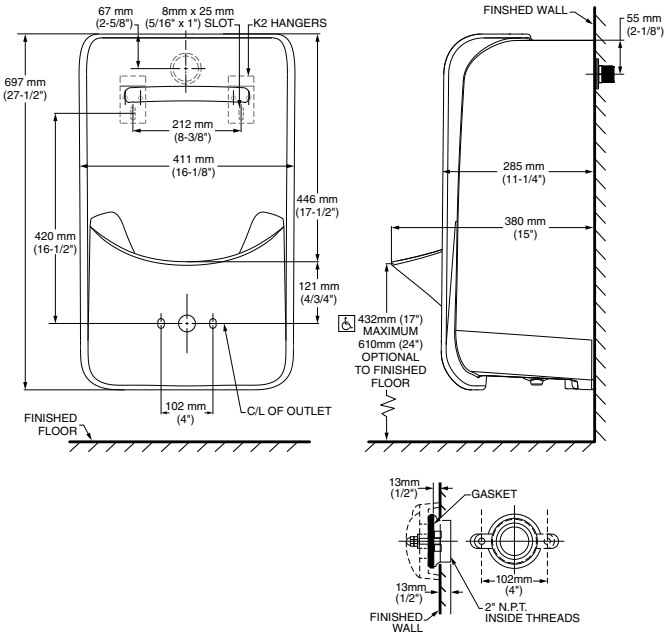
BARRIER FREE

6516001EC TOP SPUD



DETAIL OF OUTLET CONNECTION

6517001EC BACK SPUD



DETAIL OF OUTLET CONNECTION

MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES AND ANSI A117.1 ACCESSIBLE AND USABLE BUILDINGS AND FACILITIES - CHECK LOCAL CODES.

- When installed so top of rim is 432mm (17") MAXIMUM from finished floor.

NOTES:
FLUSH VALVE NOT INCLUDED AND MUST BE ORDERED SEPARATELY.
PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORTS.

IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.

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PART OF LIXIL

KOHLER. Faucets

Mach® Tripoint®

Touchless urinal flushometer, HES-powered, 0.125 gpf

K-10UH00D20

Features

- 0.125 gpf (0.47 lpf)
- Activation distance is factory-set
- Chloramine and chlorine resistance on all rubber components exposed to waterway
- Engineered for optimal performance with KOHLER® commercial fixtures
- 125-micron filter protects internal components
- High back pressure vacuum breaker
- Locking stop cap provides protection against vandalism
- No external flush volume adjustment ensures water conservation
- 24-hour automatic sentinel flush keeps trapway fresh
- Mechanical override enables flushometer to be used manually even during a power outage
- Powered by a 30 year/875,000 cycle hybrid energy cell, based on 72 uses per day

Material

- Brass construction with durable Polished Chrome finish

Technology

- Electronic infrared sensor with Tripoint® technology for accurate activation
- Patented piston technology for superior flush volume accuracy

Installation

- Intended for urinal installations with 3/4" (19 mm) top spud coupling connection

Recommended Products/Accessories

1421939 Flushometer Arm Extension Kit
1509698 Pressure Gauge Kit, 1/8”

ADA | CSA B651 | OBC

Codes/Standards

ASME A112.18.1/CSA B125.1
ASSE 1037/ASME A112.1037/CSA B125.37
EPA WaterSense®
ADA
ICC/ANSI A117.1
CSA B651
OBC

KOHLER® One-Year Limited Warranty

See website for detailed warranty information.

Available Colors/Finishes

Color tiles intended for reference only.

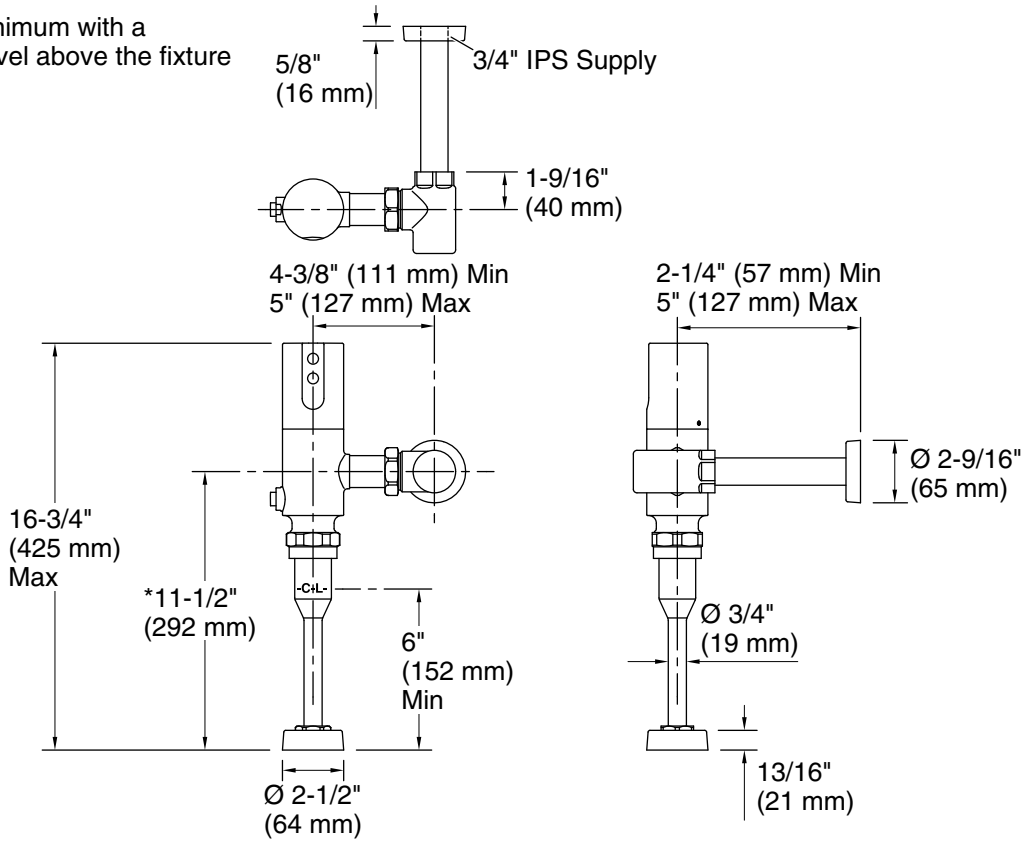
Color	Code	Description
	CP	Polished Chrome

KOHLER Faucets

Mach® Tripoint®

Touchless urinal flushometer, HES-powered, 0.125 gpf

K-10UH00D20



Technical Information

All product dimensions are nominal.

Spout:

Pressure/fixture Supply Requirements

Fixture pressure max (static):	80 psi (551.6 kPa)
Fixture pressure min (static):	25 psi (172.4 kPa)
Min flowing pressure:	25 psi (172.4 kPa)
Min flow rate:	25 gpm (94.6 lpm)

Notes

Install this product according to the installation instructions.

ADA, OBC, CSA B651 compliant when installed to the specific requirements of these regulations.

Greenbrook® Urinal

VITREOUS CHINA

BARRIER FREE

Greenbrook® Urinal

- Highly aesthetic vitreous china urinal with large footprint
- Urinal has optimized surface contours and water flushing spreader that rinses inverted back wall for superior splash protection
- High Efficiency Urinal (HEU) operates in the range of 0.125 gpf to 0.5 gpf (0.47 Lpf to 1.9 Lpf)
- 3/4" (19 mm) inlet spud with 2" (51 mm) outlet spud
- Permanent EverClean® surface inhibits the growth of stain and odor causing bacteria
- Includes removable strainer and two wall hangers

❏ **6516001EC** Greenbrook top spud

❏ **6517001EC** Greenbrook back spud

Nominal Dimensions:
15" x 16-1/8" x 27-1/2"
(380 x 411 x 698mm)

Recommended working pressure – between 20 psi at valve when flushing and 80 psi static

Compliance Certifications -
Meets or Exceeds the Following Specifications:
- ASME A112.19.2/CSA B45.1 for Vitreous China Fixtures

6516001EC Top Spud

To Be Specified:
❏ Color: ❏ White
❏ Flush Valve:

0.5 gpf Flush Valve: Sensor-Operated:
- ❏ American Standard Selectronic® #6063051.002 DC Power (Top Spud)
- ❏ American Standard Selectronic® #606B305.007 AC Power (Back Spud)

0.5 gpf Flush Valve: Manual-Operated:
- ❏ American Standard #6045051.002

0.125 gpf Flush Valve: Sensor-Operated:
- ❏ American Standard Selectronic® #6063013.002 DC Power (Top Spud)
- ❏ American Standard Selectronic® #606B301.007 AC Power (Back Spud)

0.125 gpf Flush Valve: Manual-Operated:
- ❏ American Standard #6045013.002

6517001EC Back Spud

SEE REVERSE FOR ROUGHING-IN DIMENSIONS

MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES AND ANSI A117.1 ACCESSIBLE AND USABLE BUILDINGS AND FACILITIES - CHECK LOCAL CODES.
- When installed so top of rim is 432mm (17") MAXIMUM from finished floor.

EVERCLEAN® | CEC WHEN USED WITH 0.125 gpf urinal flush valve | WHEN USED WITH 0.125 gpf or 0.5 gpf urinal flush valves | ADA COMPLIANT

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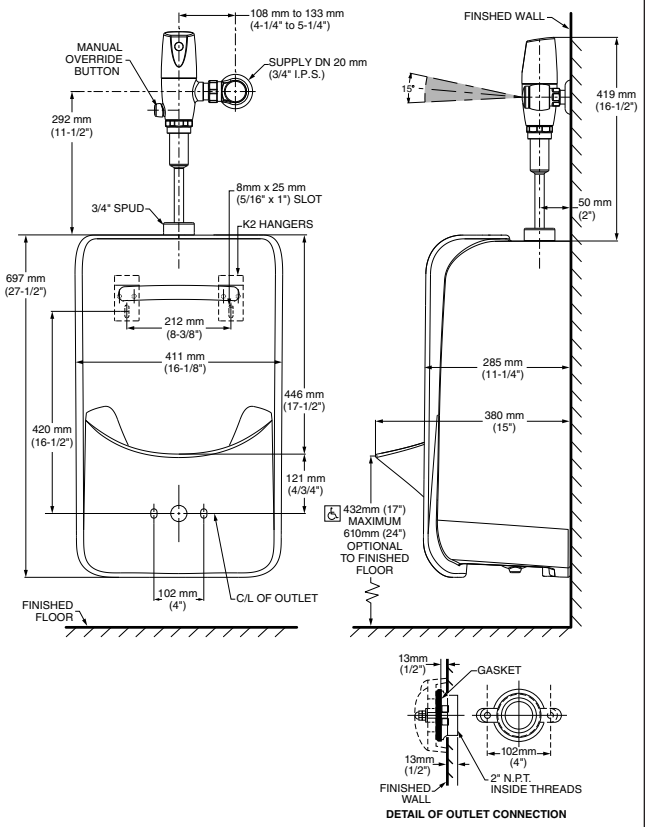
PART OF LIXIL

Greenbrook® Urinal

VITREOUS CHINA

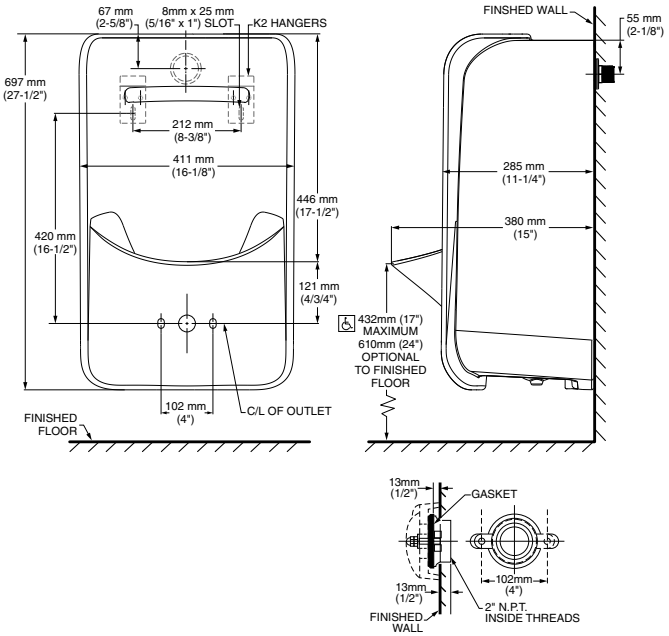
BARRIER FREE

6516001EC TOP SPUD



DETAIL OF OUTLET CONNECTION

6517001EC BACK SPUD



DETAIL OF OUTLET CONNECTION

MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES AND ANSI A117.1 ACCESSIBLE AND USABLE BUILDINGS AND FACILITIES - CHECK LOCAL CODES.

- When installed so top of rim is 432mm (17") MAXIMUM from finished floor.

NOTES:
FLUSH VALVE NOT INCLUDED AND MUST BE ORDERED SEPARATELY.
PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORTS.

IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.

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PART OF LIXIL

KOHLER. Faucets

Mach® Tripoint®

Touchless urinal flushometer, HES-powered, 0.125 gpf

K-10UH00D20

Features

- 0.125 gpf (0.47 lpf)
- Activation distance is factory-set
- Chloramine and chlorine resistance on all rubber components exposed to waterway
- Engineered for optimal performance with KOHLER® commercial fixtures
- 125-micron filter protects internal components
- High back pressure vacuum breaker
- Locking stop cap provides protection against vandalism
- No external flush volume adjustment ensures water conservation
- 24-hour automatic sentinel flush keeps trapway fresh
- Mechanical override enables flushometer to be used manually even during a power outage
- Powered by a 30 year/875,000 cycle hybrid energy cell, based on 72 uses per day

Material

- Brass construction with durable Polished Chrome finish

Technology

- Electronic infrared sensor with Tripoint® technology for accurate activation
- Patented piston technology for superior flush volume accuracy

Installation

- Intended for urinal installations with 3/4" (19 mm) top spud coupling connection

Recommended Products/Accessories

1421939 Flushometer Arm Extension Kit
1509698 Pressure Gauge Kit, 1/8”

ADA | CSA B651 | OBC

Codes/Standards

ASME A112.18.1/CSA B125.1
ASSE 1037/ASME A112.1037/CSA B125.37
EPA WaterSense®
ADA
ICC/ANSI A117.1
CSA B651
OBC

KOHLER® One-Year Limited Warranty

See website for detailed warranty information.

Available Colors/Finishes

Color tiles intended for reference only.

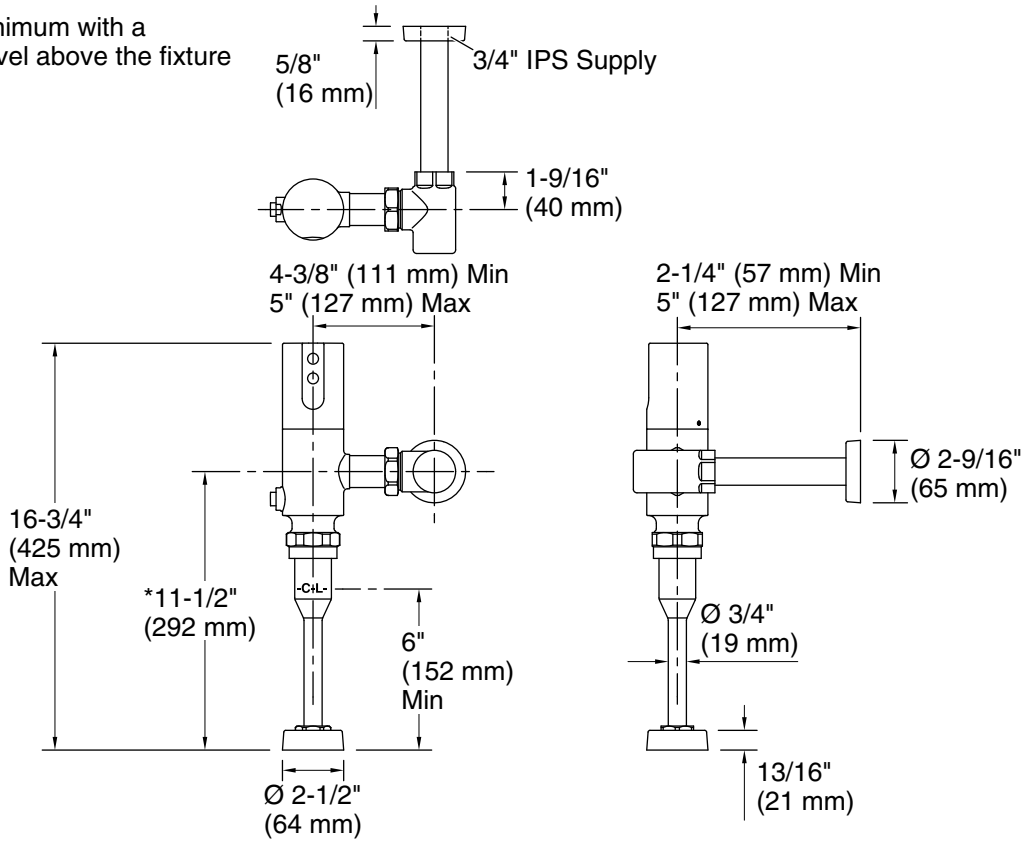
Color	Code	Description
	CP	Polished Chrome

KOHLER Faucets

Mach® Tripoint®

Touchless urinal flushometer, HES-powered, 0.125 gpf

K-10UH00D20



Technical Information

All product dimensions are nominal.

Spout:

Pressure/fixture Supply Requirements

Fixture pressure max (static):	80 psi (551.6 kPa)
Fixture pressure min (static):	25 psi (172.4 kPa)
Min flowing pressure:	25 psi (172.4 kPa)
Min flow rate:	25 gpm (94.6 lpm)

Notes

Install this product according to the installation instructions.

ADA, OBC, CSA B651 compliant when installed to the specific requirements of these regulations.

Kingston™ Ultra

Top spud flushometer bowl

K-84325

Features

- Elongated bowl offers added room and comfort
- Siphon jet
- 1.0 gpf (3.8 lpf), 1.1 gpf (4.2 lpf), 1.28 (4.8 lpf), or 1.6 gpf (6.0 lpf) depending on flushometer specified
- 11" x 8-1/4" (279 mm x 210 mm) water surface
- 1-1/2" (38 mm) top spud

Material

- Vitreous china

Technology

- Improved flush for toilet seat cover removal
- Re-engineered for strong flush performance in buildings with lower water pressure or flow
- Cast-on putty plate resists breakage
- New design eliminates gas leaks, splashing and paper shredding

Installation

- Wall-mount
- This product replaces K-4325
- This product is not designed or intended for bariatric use

ADA	CSA B651	OBC

Codes/Standards

ASME A112.19.2/CSA B45.1
DOE - Energy Policy Act 1992
EPA WaterSense®
California Energy Commission (CEC)
ADA
ICC/ANSI A117.1
CSA B651
OBC

KOHLER® One-Year Limited Warranty

See website for detailed warranty information.

Available Colors/Finishes

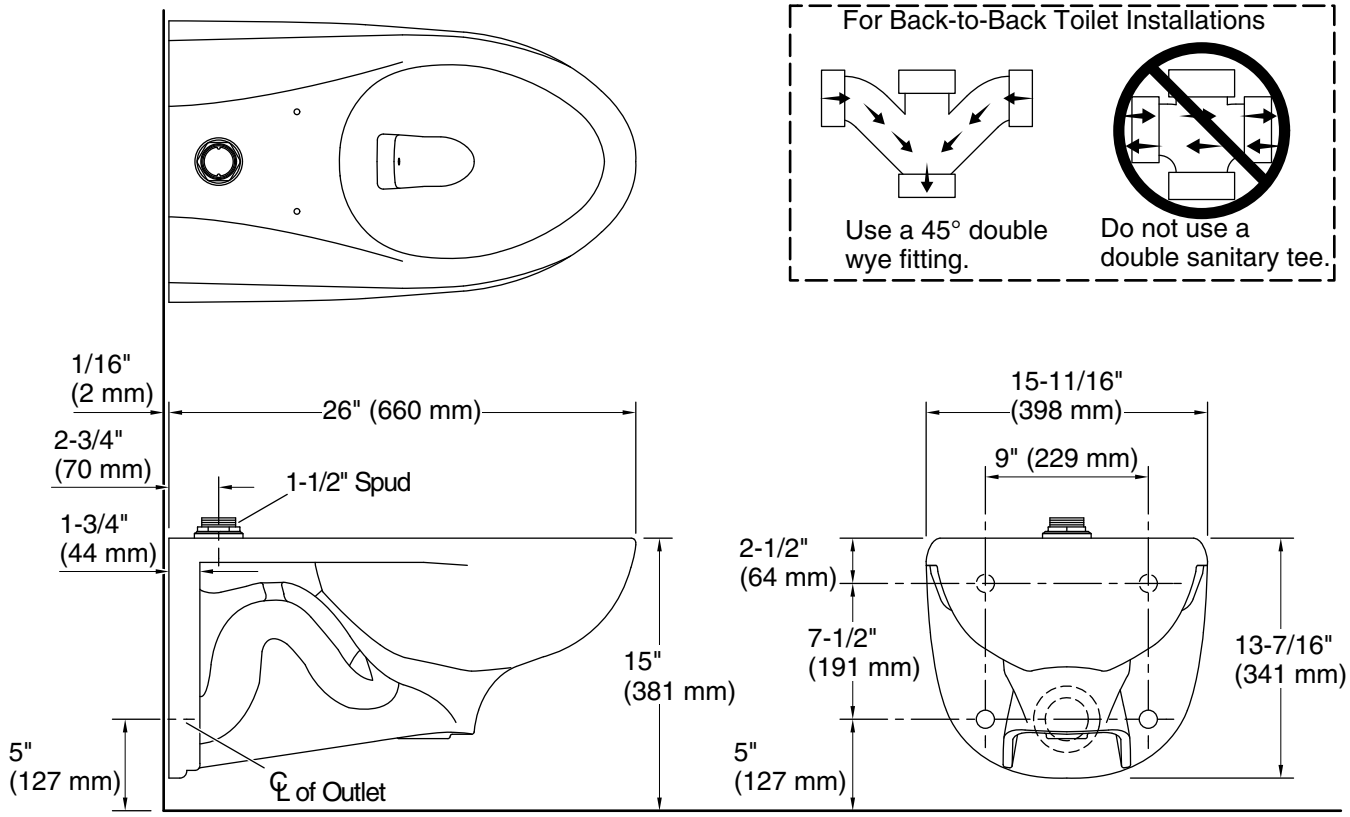
Color tiles intended for reference only.

Color	Code	Description
	0	White
	96	Biscuit
	7	Black Black™

Kingston™ Ultra

Top spud flushometer bowl

K-84325



Technical Information

All product dimensions are nominal.

Toilet type:	Wall-hung
Waste Outlet:	Wall
Bowl shape:	Elongated
Flush type:	Flushometer valve siphon
Spud size:	1 1/2, Inlet, Top
Trap passageway:	2-1/8" (54 mm)
Water surface size:	11" x 8-1/4" (279 mm x 210 mm)
Rim to water surface:	5-13/16" (148 mm)
Seat-mounting holes:	5-1/2" (140 mm)

Fixture Supply Requirements

Min static pressure:	35 psi (241.3 kPa)
Max static pressure:	80 psi (551.6 kPa)
Min flowing pressure:	25 psi (172.4 kPa)
Min flow rate:	25 gpm (94.6 lpm)

Notes

Install this product according to the installation instructions.

For back-to-back toilet installations: Use only a 45° double wye fitting.

Refer to manufacturer's instructions and local codes for flushometer requirements.

Ensure valve is braced properly.

Ensure pressure and flow are correct.

ADA, OBC, CSA B651 compliant when installed to the specific requirements of these regulations.

Plumbing codes may require elongated toilets and elongated, open-front seats in public bathrooms.

Accessibility standards may require controls to be located on the open side of the toilet.

ROYAL 111 SMO-1.28

CODE NUMBER

3910022

DESCRIPTION

1.28 gpf, Polished Chrome Finish, 1.5" Flush Connection, Fixture Connection Top Spud, Single Flush, 1" Inlet, 1" Control Stop, Electrical Override, Battery, Infrared, Royal® Exposed Sensor Water Closet Flushometer.

DETAILS

- Flush Volume: 1.28 gpf (4.8 Lpf)
- Finish: Polished Chrome (CP)
- Power Type: Battery
- Valve: Diaphragm
- Valve Body Material: Semi-red Brass
- Fixture Type: Water Closet
- Fixture Connection: Top Spud
- Rough-In Dimension: 11 ½" (292mm)
- Spud Coupling: 1 ½" (38mm)
- Supply Pipe: 1" (25mm)
- Override: Electrical
- Control Stop: 1"
- Inlet: 1"
- Flush Connection: 1.5"

FEATURES

- PERMEX® Synthetic Rubber Diaphragm with Dual Filter Bypass
- Four (4) Size C Batteries included
- “Low Battery” Flashing LED with Optional Audio Tone
- “User in View” Flashing LED
- Optional 24-Hour Sentinel Flush
- High Back Pressure Vacuum Breaker Flush Connection with Hex Coupling Nut and Spud Coupling for 1 1⁄2” Top Spud
- Sweat Solder Adapter w/Cover Tube and Cast Wall Flange w/Set Screw
- No External Volume Adjustment to Ensure Water Conservation
- Adjustable Tailpiece
- 1" I.P.S. Screwdriver Bak-Chek® Angle Stop with Vandal Resistant Stop Cap
- Diaphragm, Stop Seat and Vacuum Breaker to be molded from PERMEX® rubber compound for Chloramine resistance

COMPLIANCES & CERTIFICATIONS

(ADA Compliant, BAA Compliant, BABAA Compliant, BREEAM Water Credit, Green Globes Water Credit, LEED V4 Water Efficiency Credit, Satisfies LEED Credits, UPC Certified, WaterSense Listed)

RECOMMENDED SPECIFICATION

Valve Body, Cover, Tailpiece and Control Stop shall be in conformance with ASTM Alloy Classification for Semi- Red Brass. Valve shall be in compliance with the applicable sections of ASSE 1037 and ANSI/ASME 112.19.2.

ELECTRICAL SPECIFICATIONS

- Sensor Range: 22"–42" (559–1,067mm)

VALVE OPERATING PRESSURE (FLOWING)

15–80 PSI (103–552 kPa). Specific fixtures may require greater minimum flowing pressure - consult manufacturer requirements.

DOWNLOADS

- Optima SMO Installation Instructions
- Royal Exposed Installation Instructions
- Royal Exposed Spanish Installation Instructions
- Control Stop Repair and Maintenance Guide
- Flush Connections Flanges Repair and Maintenance Guide
- Tail Piece Repair and Maintenance Guide
- Royal Manual Diaphragm Flushometer Repair and Maintenance Guide
- EBV-89A Side Mount Repair and Maintenance Guide
- Additional Downloads

NOTES

All information contained within this document subject to change without notice.

Sloan 10500 Seymour Ave, Franklin Park, IL 60131
Phone: 800.982.5839 • Fax: 800.447.8329 • sloan.com

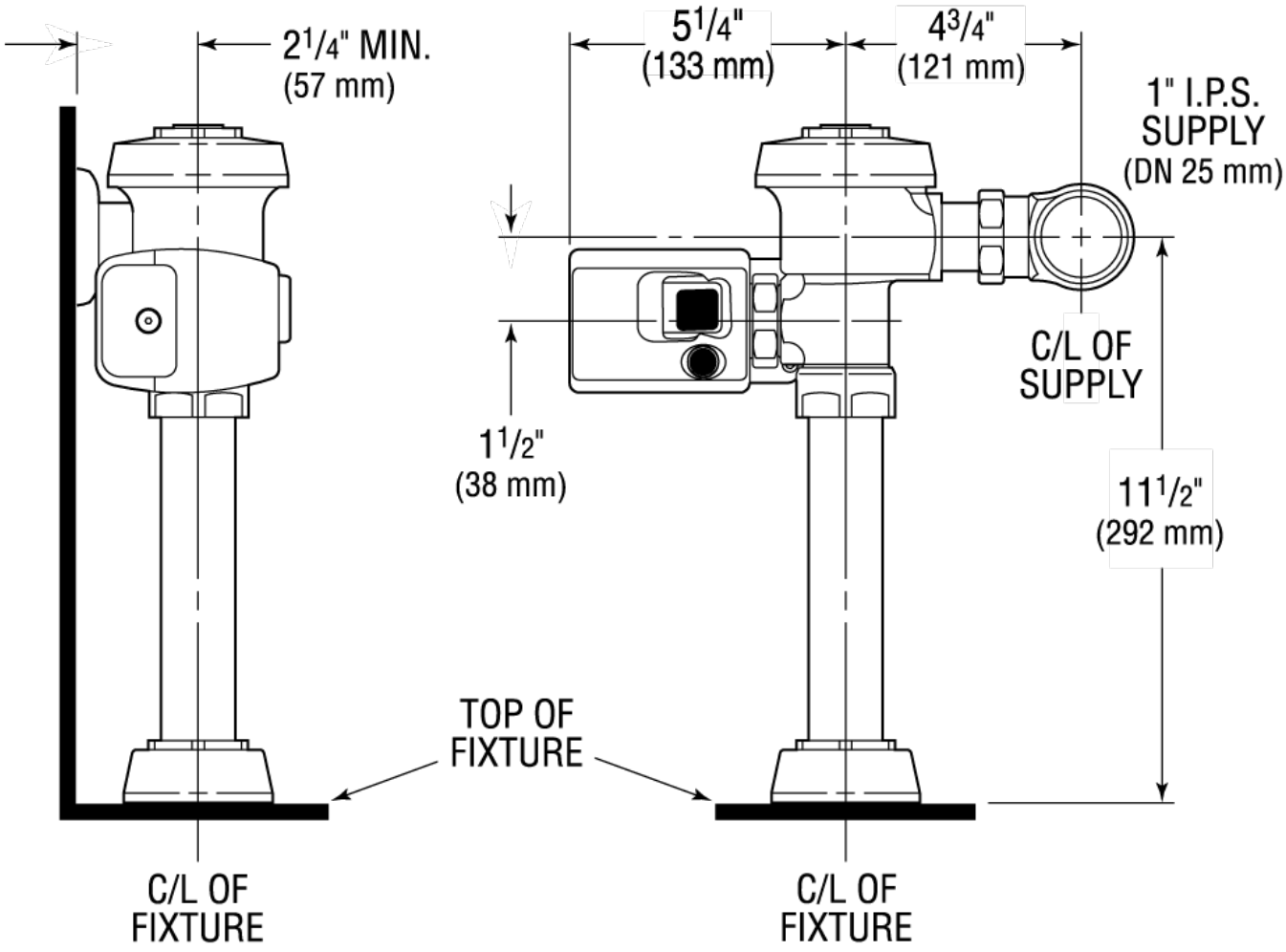
Looking for other variations of the ROYAL 111 SMO product?
View the general spec sheet with all options.

WaterSense compliant when used with a WaterSense compliant fixture

WARRANTY

View Warranty Information

ROUGH-IN



Sloan 10500 Seymour Ave, Franklin Park, IL 60131
Phone: 800.982.5839 • Fax: 800.447.8329 • sloan.com

Commercial Electric Water Heaters

GOLD SERIES

COMMERCIAL ELECTRIC WATER HEATER

Designed for use as a recovery heater having its own storage tank.
Note: Not recommended for sanitizing water applications.

FEATURES

- Meets the standby loss requirements of the U.S. Department of Energy and current edition of AHRAE/IES 90.1

INCOLOY ELEMENTS

- Heavy-duty medium watt density elements have incoloy sheathing: provide excellent protection against oxidation and scaling.

GLASSLINED TANK

- Three sizes: 50, 80 and 119 gallon capacity. Tank interior is coated with glass specially developed by A. O. Smith for water heater use. Tanks rated at 150 PSI (1034 kPa) working pressure

FUSING

- Protects all elements, thermostats, and internal wiring circuits against excess current flow. Meets National Electrical Code requirements that non-ASME tanks must have internal fusing when current draw exceeds 48 amps. Available as an option on Canadian built heaters.

STANDARD VOLTAGES

- 208, 240 and 480V single-phase and three-phase delta. Convertible from three-phase to single-phase (in field) and vice versa. 277V single-phase also available.

TERMINAL BLOCK

- Factory installed. Just bring the electrical service to the heater and connect to block.

CONTROLS

- One temperature control (adjustable through a range of 120° to 181°F) and manual reset high temperature cut-off per element. Thermostat step control may be achieved by varying settings on individual temperature controls. Located behind hinged control compartment door for quick, easy access.

OTHER STANDARD FEATURES

- Surface mounted thermostats
- Simplified circuitry, color coded for ease of service
- Two anode rods for maximum corrosion protection
- Cabinet has bonderized undercoat with baked enamel finish
- Bottom inlet and top outlet openings
- Brass drain valve
- CSA Certified and ASME rated T&P relief valve
- Single panel control box
- Foam insulation reduces costly heat loss.

3-YEAR LIMITED TANK / 1-YEAR LIMITED PARTS WARRANTY

- For complete warranty information, consult written warranty or go to hotwater.com

MODELS
DRE-52, 80, 120

CLASSIFIED UL WATER QUALITY

Low Lead Content

UL LISTED

ASME HLW
OPTIONAL

AHRI CERTIFIED® www.ahridirectory.org

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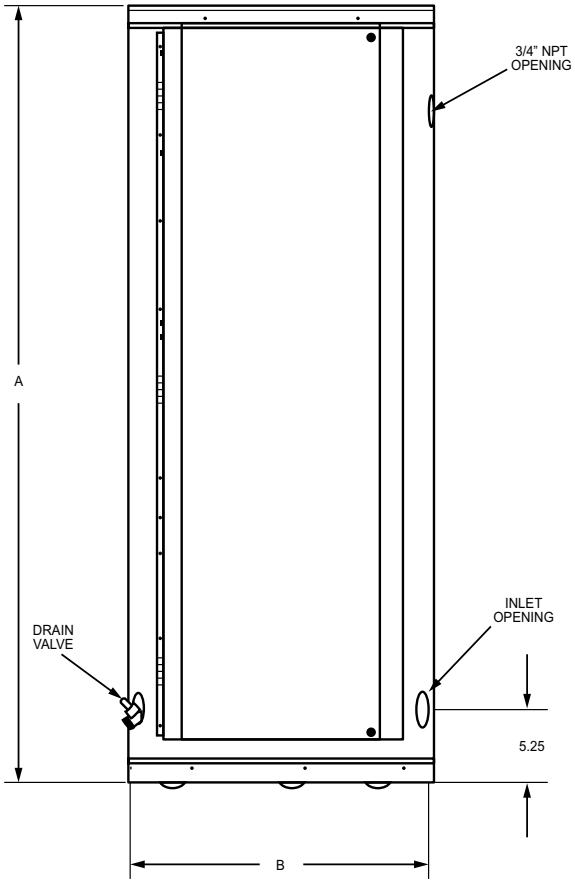
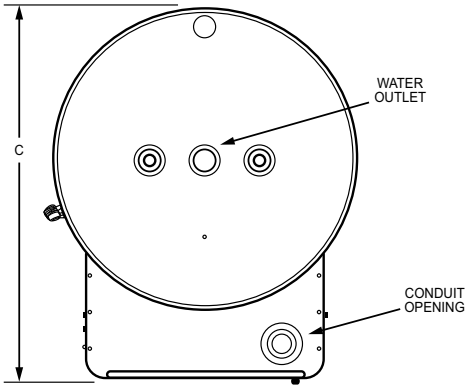
www.hotwater.com | 800-527-1953 Toll-Free USA | A. O. Smith Corporation | 500 Tennessee Waltz Parkway | Ashland City, TN 37015

Commercial Electric Water Heaters

OPTIONS

- UL and cUL listed conversion kits to adjust voltage and kW requirements in the field before and after installation
- ASME 160 psi (1103 kPa) tank construction
- International voltages – 220, 380, 400, 415, 575, and 600 volts, three phase available with Y connected elements
- MANIFOLD KITS – for multiple tank installations. Two heaters -part # 100109231, three heaters- part # 100109232 and four heaters- part # 100109233





DIMENSIONS

Model Number	Tank Capacity		Dimensions						Inlet/ Outlet (NPT)	Approx. Shipping Weight	
			A		B		C				
	gal.	litre	Inches	MM	Inches	MM	Inches	MM	Inches	lbs	kG
DRE-52	50	189	55-3/4	142	21-3/4	55.2	27	68.6	1-1/4	265	120
DRE-80	80	302	60-1/4	153	25-1/2	64.8	31	78.7	1-1/4	280	127
DRE-120	119	450	62-1/4	158.1	29-1/2	75	35	88.9	1-1/4	390	177

For ASME Construction add "A" to the model number (example: DRE 52A 24).

Commercial Electric Water Heaters

RECOVERY RATE IN GALLONS PER HOUR AT TEMPERATURE RISE OF

Standard kW Input	BTU/ Hour	30°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	110°F	120°F	130°F	140°F
		17°C	22°C	28°C	33°C	39°C	45°C	50°C	56°C	61°C	67°C	72°C	78°C
12.3	41,980	168	126	101	84	72	63	56	50	46	42	39	36
		636	477	382	318	273	238	212	189	174	159	148	136
13.5	46,075	184	138	111	92	79	69	62	55	50	46	43	40
		698	523	419	349	299	262	233	209	190	174	161	150
15	51,195	205	154	123	102	88	77	68	61	56	51	47	44
		775	582	465	388	332	291	258	233	211	194	149	166
18	61,434	246	184	148	123	105	92	82	74	67	62	57	53
		930	698	558	465	399	349	310	279	254	233	215	199
24	81,912	328	246	197	164	140	123	109	98	90	82	76	70
		1241	930	744	620	532	465	414	372	338	310	286	266
27	92,151	369	276	221	185	158	138	123	111	101	92	85	79
		1396	1047	938	609	509	523	465	410	391	340	322	299
30	102,390	410	307	246	205	176	154	137	123	112	102	95	88
		1551	1163	930	775	665	582	517	465	423	388	358	332
36	122,868	492	369	295	246	211	184	164	148	134	123	113	105
		1861	1396	1117	930	798	698	620	556	508	465	429	399
40.5	138,226	554	418	332	277	237	208	185	166	151	138	128	119
		2094	1570	1256	1047	897	785	698	628	634	582	537	498
45	153,585	615	461	369	307	263	230	205	184	168	154	142	132
		2326	1745	1398	1163	997	872	755	698	634	582	537	498
54	184,302	738	554	443	359	316	277	246	221	201	185	170	158
		2791	2094	1675	1396	1196	1047	930	837	761	696	644	598

Figured at 1 kW (3413 BTU) = 4.1 Gallons at 100°F temperature rise.

Commercial Electric Water Heaters

kW Input	Model Numbers Tank Capacity in Gallons			Number of Elements	Element Wattage	Full Load Current in Amperes						
						Single Phase				Three Phase		
	50	80	119			208V	240V	277V	480V	208V	240V	480V
12.3	DRE-52-12	DRE-80-12	DRE-120-12	3	4,100	59	51	44	26	34	30	15
13.5	DRE-52-13.5	DRE-80-13.5	DRE-120-13.5	3	4,500	64.9	56.3	48.7	28.1	37.5	32.5	16.2
15	DRE-52-15	DRE-80-15	DRE-120-15	3	5,000	72.1	62.5	54.2	31.3	41.6	36.1	18
18	DRE-52-18	DRE-80-18	DRE-120-18	3*	6,000	86.5	75	65	37.5	50	43.3	21.7
24	DRE-52-24	DRE-80-24	DRE-120-24	6	4,000	115.4	100	86.6	50	66.6	57.7	28.9
27	DRE-52-27	DRE-80-27	DRE-120-27	6	4,500	129.8	112.5	97.5	56.3	74.9	65	32.5
30	DRE-52-30	DRE-80-30	DRE-120-30	6	5,000	144.2	125	108.3	62.5	83.3	72.2	36.1
36	DRE-52-36	DRE-80-36	DRE-120-36	6*	6,000	173.1	150	130	75	99.9	86.6	43.3
40.5	N/A	DRE-80-40.5	DRE-120-40.5	9	4,500	194.7	168.8	146.2	84.4	112.4	97.4	48.7
45	N/A	DRE-80-45	DRE-120-45	9	5,000	216.3	187.5	162.5	93.8	124.9	108.3	54.1
54	N/A	DRE-80-54	DRE-120-54	9	6,000	N/A	225	194.9	112.5	149.9	129.9	65

*208 volt models may contain three (3) additional elements.
For ASME Construction add "A" to the model number (example: DRE 52A 24).

SUGGESTED SPECIFICATION

The heater(s) shall be Gold Series Commercial Electric Model Number _____ as manufactured by A. O. Smith. Heater(s) shall be rated at _____ kW,_____volts, _____ phase, 60 cycle AC, and listed by Underwriters' Laboratories and approved to the NSF Standard 5 by UL. Tank(s) shall be _____ (50, 80 or 119) gallon capacity. Tanks shall have_____ (150 [Std] or 160 [ASME]) psi working pressure and be equipped with extruded high density anode. All internal surfaces of the heater(s) exposed to water shall be glasslined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature range of 1400°F to 1600°F. Electric heating elements shall be low watt density.
Each element shall be controlled by an individually mounted thermostat and high temperature cut-off switch. All internal circuits shall be fused. The outer jacket shall be of baked enamel finish and shall be provided with full size control compartment for performance of service and maintenance through hinged front panel and shall enclose the tank with foam insulation. Electrical junction box with heavy duty terminal block shall be provided. The drain valve shall be located in the front for ease of servicing. Heater tank shall have a three year limited warranty as outlined in the written warranty. Manufacturer shall supply ASME rated temperature and pressure relief valve. Fully illustrated instruction manual to be included. Meets standby loss requirements of the U. S. Department of Energy and current edition of ASHRAE/IES 90.1.

For technical information, call 800-527-1953. A. O. Smith Corporation reserves the right to make product changes or improvements without prior notice.

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FONTANA CITY HALL

8353 Sierra St.
Fontana, CA 92335

Light Fixture Cut Sheets

SP1 – Spectra™ Large Scale

TYPE

- Four hood styles and four lens elements to configure a look of harmony with your architecture
- Symmetric or asymmetric distribution
- Post-top, wall mount arm, or pole mount arm options
- Tool-less access with captive fastener
- Adaptable appearance is perfect for contemporary or traditional installations
- Stainless steel struts
- Powder coat finish in 13 standard colors with a polymer primer sealer

SP1

1. LUMINAIRE	2. HOOD STYLE	3. LENS/ ELEMENT	4. LAMP/BALLAST	5. HOOD FINISH	6. COLOR	7. OPTIONS	8. MOUNTING

1. LUMINAIRE

☐ SP1 *(Spectra large scale)* ☐ SP1 *(Spectra LED large scale)*

2. HOOD STYLE *(HT: 29.2"/740 mm EPA: 2.27 WT: 46lbs)*

ANGLED ☐ ANG
FLARED ☐ FLR
STRAIGHT ☐ STR
DOUBLE ☐ DBL

INDIRECT ☐ IND *(Type 3)* ☐ IND *(Type 5)*
INDIRECT *FULL CUTOFF* ☐ IND - FCO

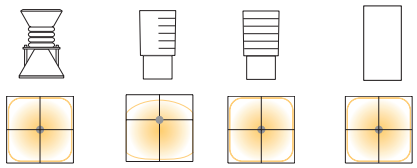
3. LENS/ELEMENT

LED
☐ VL3 (*Asymmetric distribution*) ☐ VL5 (*Symmetric distribution*)

FROSTED GLASS DIFFUSER
☐ GLA

GLASS REFRACTOR
☐ GR3 *(Type 3)* ☐ GR5 *(Type 5)*

LIGHTLY DIFFUSED LENS
☐ LDL *(Type 5)*



GLA GR3 GR5 LDL

4. LAMP/BALLAST

LED (*42 LED array. (53.8 watts for Type 3, 55.4 watts for Type 5). Bright white (5000K). 120 thru 277 volt)*
☐ 55LED-BW

COMPACT FLUORESCENT *(120 thru 277 volt)*
Use 4-pin 26, 32, or 42 watt lamp. Specify wattage
☐ CF *(-18° C starting temp)*

METAL HALIDE *(120/277 volt ballast)*
Medium base, ED-17 lamp
☐ 50MH ☐ 70MH ☐ 100MH
G12 base, T-6 ceramic lamp
☐ 70MHT6

ELECTRONIC METAL HALIDE *(120 thru 277 volt)*
Medium base, ED-17 lamp
☐ 50MHEB ☐ 70MHEB ☐ 100MHEB ☐ 150MHEB
G12 base, T-6 ceramic lamp
☐ 70MHT6EB

PULSE START METAL HALIDE *(120/208/240/277 volt ballast)*
Medium base, ED-17 lamp
☐ 150PSMH
G12 base, T-6 ceramic lamp
☐ 150PSMHT6

HIGH PRESSURE SODIUM *(120/208/240/277 volt ballast)*
Medium base, ED-17 lamp
☐ 50HPS ☐ 70HPS ☐ 100HPS ☐ 150HPS

All ballasts are factory wired for 277 volts, unless specified. Lamps not included.

5. HOOD FINISH *(OPTIONAL)*

Hood finish will match luminaire finish unless selecting one of these options. Hood underside is unfinished to develop a patina.

☐ STS *(Stainless steel)* ☐ COP *(Natural copper)*

6. COLOR

☐ AWT *(Arctic White)*
☐ BLK *(Black)*
☐ MTB *(Matte Black)*
☐ DGN *(Dark Green)*
☐ DBZ *(Dark Bronze)*
☐ WRZ *(Wheathered Bronse)*
☐ BRM *(Metallic Bronze)*
☐ VBL *(Verde Blue)*
☐ CRT *(Corten)*
☐ MAL *(Matte Aluminum)*
☐ MDG *(Medium Grey)*
☐ ATG *(Antique Green)*
☐ LGY *(Light Grey)*
☐ RAL/PREMIUM COLOR *(Provide RAL)*
☐ CUSTOM COLOR *(Provide color chip for matching)*

7. OPTIONS

☐ 347 *(347 volt ballast 120/227/347. **Not available with electronic ballast or LED**)*
☐ AD5 *(SP1 adaptor. Designed to slip over a 5"/127 mm O.D. pole)*
☐ ULS *(Upper lens shield in the upper lens area. Provides cutoff optics (1.2% uplight). **Indirect only. Not available with FCO/LED**)*
☐ LDL *(Lightly diffused lens)*
☐ SCP[9] (Programmable motion control, factory default is 50%)

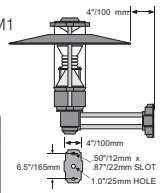
5. MOUNTING

All arms regardless of hood diameter, have a 4"/100mm distance from the edge of the shade to the pole centerline or face of the wall.

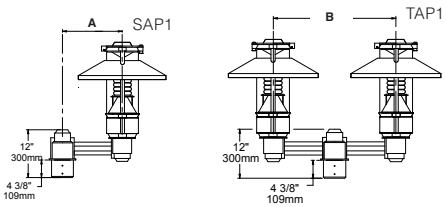
WALL MOUNT
☐ AWM1 *(Wall plate is 8.5"/216mm x 4.75"/120mm)*

POLE MOUNT (*(Slips over a 4"/100mm pole)*
☐ SAP1 ☐ TAP1

AWM1



Hood Style	A	B
Angled (ANG	15"/375mm	30"/750mm
Flared (FLR)	17 1/2"/438mm	35"/875mm
Straight (STR)	21 3/4"/544mm	43 1/2"/1,088mm
Double (DBL)	21 3/4"/544mm	43 1/2"/1,088mm



Visit www.aal.net for Arms, Poles & Accessories Specification Guide

SPECIFICATIONS

HOUSING
The fixture housing shall be all cast aluminum, A356 alloy, free of any porosity, foreign materials, or cosmetic fillers. The ballast shall be mounted internally and accessed by loosening two captive bolts and lifting off the top of the fixture. The top cover shall be hinged and secured with one captive tool-less fastener for relamping. The top shall seal with a molded silicone gasket. The upper reflector cone shall be matte finished anodized aluminum. The lens shall be clear seamless acrylic sealed to the housing with a molded silicone gasket on the top and bottom. The vertical struts shall be 316 stainless steel tubing. All internal and external hardware shall be stainless steel. All female threads on the aluminum parts shall be cast-in-place brass inserts to ensure no thread seizure.

HOOD
The hoods shall be spun from 6061 T-6 aluminum, 316 stainless steel or 110 copper. The shade shall have hemmed or beaded edges for added strength. The underside of the painted shades and all indirect shades (of aluminum, stainless steel or copper) shall be painted a high reflectance white. Stainless steel and copper shade shall be unfinished on both sides, except for the indirect (IND) models. Stainless steel hood not available with FCO model

LENSES/ELEMENTS
All lenses shall be molded, seamless high impact lighting grade acrylic.

The GLA element shall be frosted borosilicate glass with a twist on connection to the lower cone assembly. The cone shall be matte finished anodized aluminum.

The GR3 and GR5 shall be precision molded borosilicate glass refractors with the Type 3 or Type 5 distribution. The refractors shall be mounted to a gasketed aluminum holder with an internal pressure plate.

The LDL lens shall be acrylic with a lightly diffused internal finish.

The IND indirect fixtures shall have a clear acrylic lens with a lower reflector cone and an upper diffusing cone.

See next page

JOB _____
TYPE _____
NOTES _____

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SP1 – Spectra™ Large Scale | TYPE

The one-piece hood and lens shield provides IES full cutoff classification meaning there is zero light emitted above 90° horizontal. The lens shield is aluminum and painted to match the fixture color (IND-FCO only.)

ELECTRICAL
The ballast shall be integral to the fixture, mounted on a prewired module with a quick disconnect plug. The ballast module shall have keyhole slots and be removable by loosening two screws. Sockets shall be pulse rated porcelain. HID ballasts shall be high power factor, rate for -30°C starting. The compact fluorescent ballast shall be electronic for use with 4 pin lamps (GX24q-4 socket) rated for -18°C starting temperature.

FINISH
Fixture finish shall consist of a five stage pretreatment regimen with a polymer primer sealer, oven dry off, and top coated with a thermoset super TGIC polyester powder coat finish. The finish shall meet the AAMA 605.2 performance specification which includes passing a 3000 hour salt spray test for corrosion resistance.

ARM AND POLE MOUNTING
The SP1 shall slip over a 4"/100 mm round pole and secured with six stainless steel set screws.

The pole mounted arm for a single fixture (SAP) and pole mounted arm for two fixtures at 180° (TAP) shall have a cast aluminum post top and fixture fitter with two round horizontal stainless steel bars. The post fitter shall slip over a 4"/100 mm pole and be secured with six stainless steel set screws.

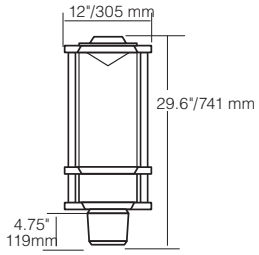
The wall mounted arms for a SP1 fixture shall have a cast aluminum wall plate, cover and fixture fitter with two round horizontal stainless steel bars. The cover shall secure to the wall plate with four stainless steel set screws

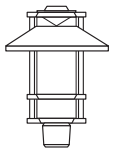
CERTIFICATION
Fixtures shall be listed with ETL for outdoor, wet location use, UL1598 and Canadian CSA Std. C22.2 no.250.

WARRANTY
Spectra LED, including housing, LEDs and electrical components, is warranted for five years. Non LED fixture is warranted for three years. Ballast components carry the ballast manufacturer's limited warranty. Any unauthorized return, repair, replacement or modification of the Product(s) shall void this warranty. This warranty applies only to the use of the Product(s) as intended by AAL and does not cover any misapplication or misuse of said Product(s), or installation in hazardous or corrosive environments.

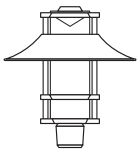
AAL reserves the right to change product specifications without notice.

DIMENSIONS

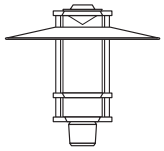




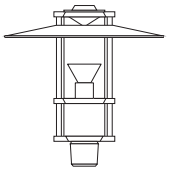
Angled Hood (ANG)
DIA: 22"/559mm



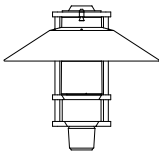
Flared Hood (FLR)
DIA: 27"/686mm



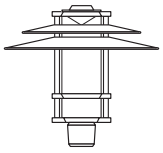
Straight Hood (STR)
DIA: 31.5"/801mm



Indirect (IND Type 3/Type 5)
DIA: 31.5"/801mm



Indirect- full cutoff (IND - FCO)
DIA: 32"/813mm



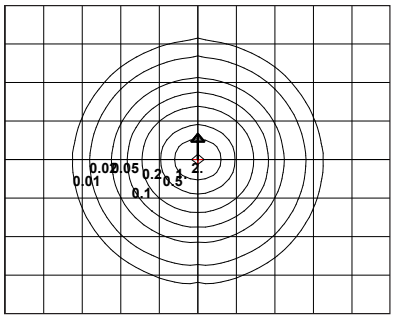
Double Hood (DBL)
DIA: 31.5"/801mm

SP1 IND FCO 100HPS

WATTAGE: 138 LUMEN OUTPUT: 2097 EFFICACY: 68.8

B1 U0 G0

FORWARD LIGHT			LUMEN
FL	30°	3.1%	294
FM	60°	5.8%	551
FH	80°	2.0%	187
FVH	90°	0.1%	6
BACK LIGHT			
BL	30°	3.1%	294
BM	60°	5.8%	551
BH	80°	2.0%	187
BVH	90°	0.1%	6
UPLIGHT			
UL	100°	0%	0
UH	180°	0%	0



20' MOUNTING HEIGHT

Mounting Height	Multiplier
10	4.000
15	1.778
20	1.000
25	0.640
30	0.444
35	0.327
40	0.250
45	0.198
50	0.160

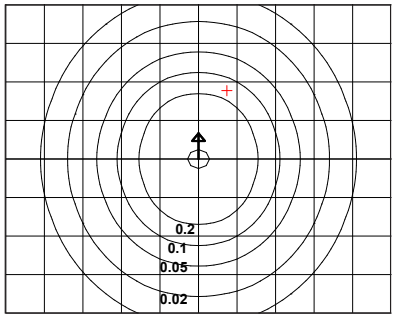
UPLIGHT 0%
DOWNLIGHT 100%

SP1 VL5 55LED BW

WATTAGE: 55.5 LUMEN OUTPUT: 2460 EFFICACY: 44.3

B1 U3 G2

FORWARD LIGHT			LUMEN
FL	30°	2.4%	60
FM	60°	20%	492
FH	80°	18.7%	461
FVH	90°	4.3%	107
BACK LIGHT			
BL	30°	2.4%	60
BM	60°	20%	492
BH	80°	18.7%	461
BVH	90°	4.3%	107
UPLIGHT			
UL	100°	4.8%	117
UH	180°	4.2%	103



20' MOUNTING HEIGHT

Mounting Height	Multiplier
10	4.000
15	1.778
20	1.000
25	0.640
30	0.444
35	0.327
40	0.250
45	0.198
50	0.160

UPLIGHT 9.0%
DOWNLIGHT 91%

IES files can be found at www.aal.net

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insight lighting

ARGO PRO

PERFORMANCE LINEAR | COLOR CHANGING + TUNABLE WHITE

PROJECT: TYPE: FIXTURE CATALOG #: AP - - - - - - - - - -

PROFILE

nitro color

MARATHON

QUAD PERFECT™

OUTPUT	LO (5 W/FT), MO (10 W/FT), HO (15 W/FT), VO (20 W/FT)
OPTICAL DISTRIBUTIONS	10°, 20°, 30°, 40°, 60°, 80°, 90° - SEE PAGE 2 FOR DETAILS
LED CONFIGURATIONS	PATENTED QUAD PERECT™ TECHNOLOGY POWERED BY NITRO COLOR TECHNOLOGY RGB-AMBER, RGB22K, RGB27, RGB30K, RGB35K, RGB40K RG-ROYAL BLUE30K, RG-ROYAL BLUE-40K , TUNABLE WHITE (2200K-6500K)
PERFORMANCE	UP TO: 4,276 LUMENS, 47,764 PEAK CANDELA
VOLTAGE	120VAC, 277VAC 380VDC - REMOTE DRIVER, POWERED BY MARATHON TECHNOLOGY
CONTROL	DMX/RDM
FIXTURE LENGTHS	12", 24", 36", 48", 60" (NOMINAL LENGTHS)
WEIGHT	2.41 LB/FT
HOUSING	PRECISION EXTRUDED ALUMINUM
LENS	HIGH DENSITY TEMPERED GLASS
FINISH	HIGH DURABILITY POWDER COATING
OPERATING TEMP.	-20° C TO 50° C
WARRANTY	5-YEAR LIMITED
LUMEN MAINTENANCE	75,000 HOURS
CERTIFICATION	ETL AND CETL FOR IP67, IK07, 3G, COMPLIES WITH BUY AMERICAN ACT

MARATHON TECHNOLOGY

Create long run lengths on a single driver with Insight's MARATHON 380VDC power system, delivering dramatically increased reliability and lower lifetime cost.

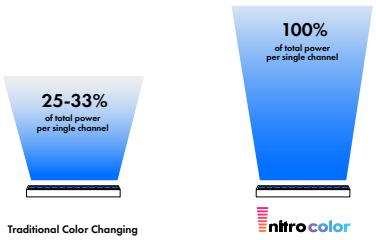
ADVANCED CABLE SYSTEM

Insight Lighting's Advanced Cable System is designed for plug-and-play installations, delivering unmatched consistency in lighting performance.

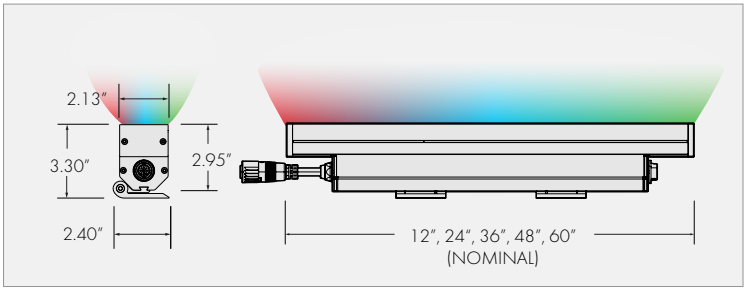
POWER & DATA BOX WITH SURGE PROTECTION

Insight's PROSURGE power & data box transitions data and power, with 10 kVA surge protection for Insight's Plug & Play cable system.

NITRO COLOR TECHNOLOGY

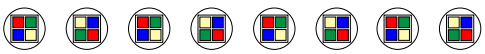


PROFILE



QUAD CLUSTER LED CONFIGURATION

The quad array integrates multiple colors (i.e. red, green, blue, white) into a single location for immediate and superior color saturation. This is ideal for direct line of sight applications where the face of the fixture is visible, creating color consistency between the luminaire and the illuminated surface. LED color combinations may be customized to suit any application (i.e. royal blue, cyan, lime, white, etc.). Please contact the factory for special branding requirements.



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P.: 505.345.0888 | insightlighting.com

PROJECT: TYPE: FIXTURE CATALOG #: AP - - - - - - - - - -

FIXTURE SPECIFICATION

Separate options with dashes

AP								
1	2	3	4	5	6	7	8	9

1 FIXTURE

ARGO PRO	AP

2 WATTAGE

LOW OUTPUT 5 W/FT	LO
MEDIUM OUTPUT 10 W/FT	MO
HIGH OUTPUT 15 W/FT	HO
MAXIMUM OUTPUT 20 W/FT	VO

3 CCT

RED, GREEN, BLUE, AMBER	RGBAM
RED, GREEN, BLUE, 22K	RGB22
RED, GREEN, BLUE, 27K	RGB27
RED, GREEN, BLUE, 30K	RGB30
RED, GREEN, BLUE, 35K	RGB35
RED, GREEN, BLUE, 40K	RGB40
RED, GREEN, ROYAL BLUE, 30K	RGY30
RED, GREEN, ROYAL BLUE, 40K	RGY40
TUNABLE WHITE Kelvin tunable 2200K-6500K	2265K

Contact factory for additional CCT combinations

4 OPTICAL DISTRIBUTION

10° X 10°	1010
10° X 30°	1030
10° X 60°	1060
10° X 90°	1090
20° X 20°	2020
20° X 30°	2030
20° X 60°	2060
20° X 90°	2090
30° X 30°	3030
30° X 60°	3060
30° X 90°	3090
40° X 40°	4040
40° X 60°	4060
40° X 90°	4090
60° X 60°	6060
80° X 80°	8080
90° X 90°	9090
ASYM GRAZE UPLIGHT, LEFT POWER FEED [1]	ASUL
ASYM GRAZE UPLIGHT, RIGHT POWER FEED [1]	ASUR
ASYM GRAZE DOWNLIGHT, LEFT POWER FEED [1]	ASDL
ASYM GRAZE DOWNLIGHT, RIGHT POWER FEED [1]	ASDR

[1] Asym Graze: See page 5 for details.

5 FIXTURE LENGTH

12"	12
24"	24
36"	36
48"	48
60"	60

6 VOLTAGE

INTEGRAL

120VAC	120
277VAC	277

Contact factory for additional voltages

MARATHON REMOTE TECHNOLOGY

380VDC	MAR

380VDC requires Insight's Marathon 380VDC remote power supply. Must be ordered separately. See page 4 for details.

7 CONTROL OPTIONS

DMX SYSTEM RESOLUTION	DMXSY
DMX FIXTURE RESOLUTION	DMXFX
DMX FT BY FT RESOLUTION	DMXFT

Default factory setting is DMX System Resolution

Fixtures are not pre-addressed/labeled at the factory. A DMXCAT Tool is required for on-site fixture resolution/addressing. See page 4 for details.

A CDS/RDM Distribution Kit is required. Must be ordered separately. See page 4 for details.

DMX controls are required. Order separately.

8 FIXTURE FINISH

TEXTURED WHITE	TWH
TEXTURED BLACK	TBL
TEXTURED BRONZE	TBR
TEXTURED LIGHT BRONZE	TLB
TEXTURED GRAY	TGR
TEXTURED NATURAL	TNA
TEXTURED SANDSTONE	TSA
ANODIZED ALUMINUM	ANA

Includes corrosion resistant finish.

CUSTOM COLOR	CUS

Contact factory for custom color. Additional charges will apply.

9 OPTIONS

WHITE CABLE	WCA

White fixtures are provided with white cables and connectors. All other fixture finishes are provided with black cabling unless WC option is specified.

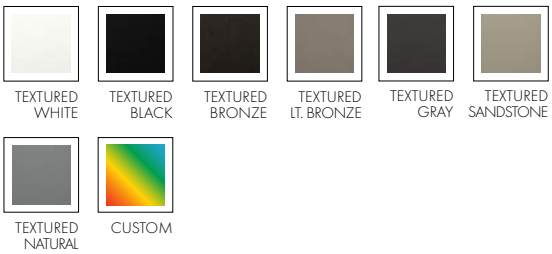
CORROSION RESISTANT FINISH	CRF

CRF complies with ASTM B117. CRF is recommended for coastal or extreme exterior environments

BUILD AMERICA BUY AMERICA ACT	BAB

Complies with BAA
Contact factory for current offering.

STANDARD FINISHES



OPTIONS

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P.: 505.345.0888 | insightlighting.com

PROJECT: TYPE: FIXTURE CATALOG #: AP - - - - - - - - - -

ORDERING LOGIC: MOUNTING - REQUIRED (ORDER SEPARATELY)

SA - -

1 2

1 MOUNTING OPTION	PART NUMBERS 12" FIXTURE	24" - 60" FIXTURE
FIXED MOUNT (SEE PAGE 8 FOR DETAILS)	SA28170-1	SA28170
HINGE MOUNT (SEE PAGE 8 FOR DETAILS)	SA28104-1	SA28104
WALL MOUNT (SEE PAGE 8 FOR DETAILS)	SA28105-1	SA28105
GROUND MOUNT (SEE PAGE 9 FOR DETAILS)	SA28106-1	SA28106
EXTENDED ARM, WALL - 2.5" ARM (SEE PAGE 9 FOR DETAILS)	SA28107-1-6	SA28107-6
EXTENDED ARM, WALL - 8.5" ARM (SEE PAGE 9 FOR DETAILS)	SA28107-1-12	SA28107-12
EXTENDED ARM, WALL - 14.5" ARM (SEE PAGE 9 FOR DETAILS)	SA28107-1-18	SA28107-18
EXTENDED ARM, WALL - 20.5" ARM (SEE PAGE 9 FOR DETAILS)	SA28107-1-24	SA28107-24
EXTENDED ARM, GROUND - 6" ARM (SEE PAGE 10 FOR DETAILS)	SA28108-1-6	SA28108-6
EXTENDED ARM, GROUND - 12" ARM (SEE PAGE 10 FOR DETAILS)	SA28108-1-12	SA28108-12
EXTENDED ARM, GROUND - 18" ARM (SEE PAGE 10 FOR DETAILS)	SA28108-1-18	SA28108-18
EXTENDED ARM, GROUND - 24" ARM (SEE PAGE 10 FOR DETAILS)	SA28108-1-24	SA28108-24
PENDANT, CEILING - 6" PENDANT (SEE PAGE 10 FOR DETAILS)	SA28108-1-6	SA28108-6
PENDANT, CEILING - 12" PENDANT (SEE PAGE 10 FOR DETAILS)	SA28108-1-12	SA28108-12
PENDANT, CEILING - 18" PENDANT (SEE PAGE 10 FOR DETAILS)	SA28108-1-18	SA28108-18
PENDANT, CEILING 24" PENDANT (SEE PAGE 10 FOR DETAILS)	SA28108-1-24	SA28108-24
STAKE MOUNT (SEE PAGE 11 FOR DETAILS)	SA28110-1	SA28110

2 MOUNTING FINISH	
TEXTURED WHITE	TWH
TEXTURED BLACK	TBL
TEXTURED BRONZE	TBR
TEXTURED LIGHT BRONZE	TLB
TEXTURED GRAY	TGR
TEXTURED NATURAL	TNA
TEXTURED SANDSTONE	TSA
ANODIZED ALUMINUM	ANA

Includes corrosion resistant finish.

CUSTOM COLOR	CUS

Contact factory for custom color. Additional charges will apply.

ORDERING LOGIC: OPTIONAL ACCESSORIES (ORDER SEPARATELY)

SA - -

1 2

SA - -

1 2

1 SHIELDING ACCESSORIES	PART NUMBER 12" FIXTURE	24" FIXTURE	36" FIXTURE	48" FIXTURE	60" FIXTURE
LOUVER	SA28111-1	SA28111-2	SA28111-3	SA28111-4	SA28111-5
VISOR	SA28112-1	SA28112-2	SA28112-3	SA28112-4	SA28112-5
SHIELD/MASKING PLATE	SA28113-1	SA28113-2	SA28113-3	SA28113-4	SA28113-5

PROLINK CONDUIT J-BOX	PART NUMBER
PROLINK CONDUIT J-BOX	SA28177

PROLINK CONNECT ACCESSORIES (NOT AVAILABLE WITH 12" FIXTURES)	PART NUMBER
PROLINK CONNECT START	SA28178
Not available with Extended Arm Wall. See SA28179 below.	
PROLINK CONNECT START FOR EXTENDED ARM WALL	SA28179
Intented for Extended Arm, Wall only (SA28107-X)	
PROLINK CONNECT MID FOR PLUG AND PLAY SYSTEM	SA28180
ProLink Mid is intended for straight runs only	
PROLINK CONNECT END	SA28181
ProLink Connect End for end of continuous run.	

2 ACCESSORY FINISH	
TEXTURED WHITE	TWH
TEXTURED BLACK	TBL
TEXTURED BRONZE	TBR
TEXTURED LIGHT BRONZE	TLB
TEXTURED GRAY	TGR
TEXTURED NATURAL	TNA
TEXTURED SANDSTONE	TSA
ANODIZED ALUMINUM	ANA

Includes corrosion resistant finish.

CUSTOM COLOR	CUS

Contact factory for custom color. Additional charges will apply.

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PROJECT: TYPE: FIXTURE CATALOG #: AP - - - - - - - - - -

ORDERING LOGIC: CABLES - SEE PAGE 14

EL - 1

EL - 2

EL - 3

1 LEADER CABLES

	PART NUMBER BLACK	PART NUMBER WHITE
5.0 FT LEADER CABLE	EL12430-5-B	EL12430-5-W
10.0 FT LEADER CABLE	EL12430-10-B	EL12430-10-W

A leader cables is required for standard J-box installations

2 JUMPER CABLES

	PART NUMBER BLACK	PART NUMBER WHITE
1.0 FT JUMPER CABLE	EL12288-1-B	EL12288-1-W
2.0 FT JUMPER CABLE	EL12288-2-B	EL12288-2-W
5.0 FT JUMPER CABLE	EL12288-5-B	EL12288-5-W
10.0 FT JUMPER CABLE	EL12288-10-B	EL12288-10-W
25.0 FT JUMPER CABLE	EL12288-25-B	EL12288-25-W

A jumper cable is required for ProStart Plug & Play Starter with Surge Protection (see below for details)

3 DMX TERMINATOR

	PART NUMBER BLACK	PART NUMBER WHITE
DMX TERMINATOR	EL12291–B	EL12291–W

One required per DMX run

ORDERING LOGIC: PROSURGE POWER & DATA BOX WITH SURGE PROTECTION (OPTIONAL)

1

1 PROSURGE POWER & DATA BOX

	PART NUMBER
PROSURGE POWER & DATA BOX - FOR MARATHON DMX	SA28173
PROSURGE POWER & DATA BOX - FOR 120-277V DMX	SA28176

Transitions Data and Power, with 10 kVA surge protection for Insight's Plug and Play cable system. One required per continuous run.

A jumper cable is required.

Not available with ProLink Conduit Box

ORDERING LOGIC: MARATHON REMOTE 380VDC TECHNOLOGY

MARATHON

1

1 MARATHON REMOTE POWER SUPPLY - REQUIRED FOR MARATHON REMOTE

	PART NUMBER
MARATHON REMOTE POWER SUPPLY, 380VDC, 2300W, 277V INPUT, IP67	EL12419

ORDERING LOGIC: DMX TOOLS - REQUIRED

1

1 DMX/RDM DISTRIBUTION KIT

	PART NUMBER
CDS-RDM - DMX/RDM DISTRIBUTION KIT - IP67	SA27411

Consists of 4 output

Each output is limited to (1) run per output - up to 96 fixtures max

1

1 REMOTE DMX/RDM MONITORING TOOL

	PART NUMBER
DMX/RDM ADDRESSING & MONITORING TOOL	SA27636

Uses Bluetooth LE technology for communication with the smartphone and the DMXcat app (up to a 50' range). Allows for on-site fixture resolution and addressing.

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MAXIMUM RUN LENGTH IN FEET

MAXIMUM POSSIBLE RUN LENGTHS IN FEET
ALL DISTANCES ARE CALCULATED AS CONTINUOUS RUNS

MAXIMUM RUN LENGTH IN FEET			
	INTEGRAL POWER SUPPLY 120VAC	**INTEGRAL POWER SUPPLY 277VAC**	MARATHON **MARATHON TECHNOLOGY REMOTE POWER SUPPLY 380VDC, 2300W, 277V INPUT**
CONTROL	**FIXTURE RUN LENGTH**	**FIXTURE RUN LENGTH**	**FIXTURE RUN LENGTH**
DMX			
LO OUTPUT 5W/FT	96 FIXTURES MAX NOT TO EXCEED 268'	96 FIXTURES NOT TO EXCEED 619'	96 FIXTURES NOT TO EXCEED 460'
MO OUTPUT 10W/FT	96 FIXTURES MAX NOT TO EXCEED 156'	96 FIXTURES MAX NOT TO EXCEED 360'	96 FIXTURES MAX NOT TO EXCEED 230'
HO OUTPUT 15W/FT	96 FIXTURES MAX NOT TO EXCEED 104'	96 FIXTURES MAX NOT TO EXCEED 240'	96 FIXTURES MAX NOT TO EXCEED 153'
VO OUTPUT 20W/FT	78'	96 FIXTURES MAX NOT TO EXCEED 180'	96 FIXTURES MAX NOT TO EXCEED 115'

ALL CALCULATIONS ARE BASED ON 16AWG CABLE.
ADDING JUMPER CABLES OR REMOVING FIXTURES TO A CONTINUOUS RUN WILL IMPACT THE OVERALL DISTANCE AND RUN LENGTH.
CONTACT FACTORY FOR MORE INFORMATION.

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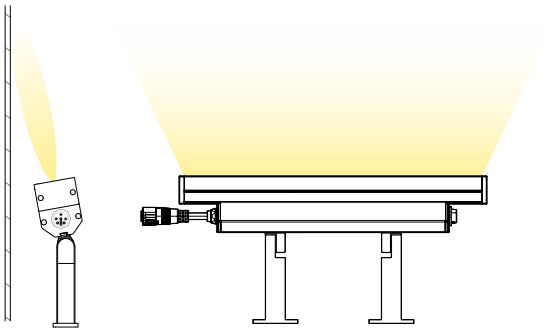
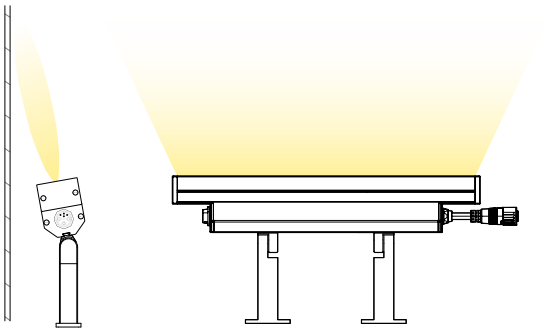
ASYMMETRIC DISTRIBUTIONS/LIGHT DIRECTION /FEED LOCATIONS

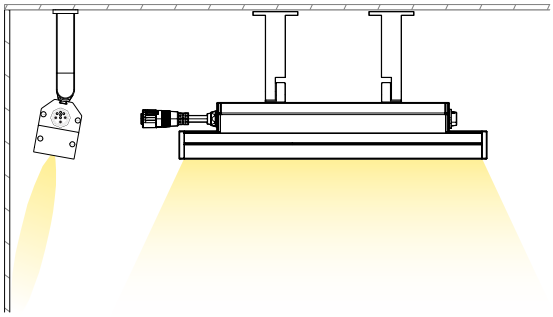
ASYMMETRIC GRAZE UPLIGHT | LEFT POWER FEED



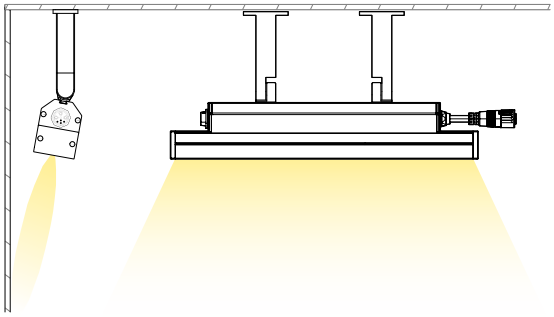
ASYMMETRIC GRAZE UPLIGHT | RIGHT POWER FEED



ASYMMETRIC GRAZE DOWNLIGHT | LEFT POWER FEED



ASYMMETRIC GRAZE DOWNLIGHT |RIGHT POWER FEED



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PERFORMANCE

BASED ON 48" FIXTURE

		LOW OUTPUT				MEDIUM OUTPUT				HIGH OUTPUT				MAX OUTPUT			
OPTIC	CCT'S	LUMENS	WATTS	LM/W	PEAK CANDELA CBCP	LUMENS	WATTS	LM/W	PEAK CANDELA CBCP	LUMENS	WATTS	LM/W	PEAK CANDELA CBCP	LUMENS	WATTS	LM/W	PEAK CANDELA CBCP
10° X 10°	RGB40	868	20	43.4	9738	1736	40	43.4	19476	2604	60	43.4	29214	3472	80	43.4	38952
	RED	241	16	15.4	2831	482	31	15.4	5662	723	47	15.4	8493	964	62	15.4	11324
	GREEN	1019	18	55.7	11167	2038	37	55.7	22334	3057	55	55.7	33501	4076	73	55.7	44668
	BLUE	350	19	18.0	3687	700	39	18.0	7374	1050	58	18.0	11061	1400	78	18.0	14748
	WHITE	1028	20	51.7	11941	2056	40	51.7	23882	3084	60	51.7	35823	4112	80	51.7	47764
10° X 30°	RGB40	781	20	39.1	3828	1562	40	39.1	7656	2343	60	39.1	11484	3124	80	39.1	15312
	RED	229	16	14.7	1153	458	31	14.7	2306	687	47	14.7	3459	916	62	14.7	4612
	GREEN	915	18	50.0	4380	1830	37	50.0	8760	2745	55	50.0	13140	3660	73	50.0	17520
	BLUE	319	19	16.4	1484	638	39	16.4	2968	957	58	16.4	4452	1276	78	16.4	5936
	WHITE	925	20	46.5	4706	1850	40	46.5	9412	2775	60	46.5	14118	3700	80	46.5	18824
10° X 60°	RGB40	765	20	38.3	2176	1530	40	38.3	4352	2295	60	38.3	6528	3060	80	38.3	8704
	RED	204	16	13.1	600	408	31	13.1	1200	612	47	13.1	1800	816	62	13.1	2400
	GREEN	898	18	49.1	2513	1796	37	49.1	5026	2694	55	49.1	7539	3592	73	49.1	10052
	BLUE	311	19	16.0	834	622	39	16.0	1668	933	58	16.0	2502	1244	78	16.0	3336
	WHITE	926	20	46.5	2692	1852	40	46.5	5384	2778	60	46.5	8076	3704	80	46.5	10768
10° X 90°	RGBW	750	20	37.5	1238	1500	40	37.5	2476	2250	60	37.5	3714	3000	80	37.5	4952
	RED	203	16	13.0	346	406	31	13.0	692	609	47	13.0	1038	812	62	13.0	1384
	GREEN	880	18	48.1	1434	406	31	13.0	692	2640	55	48.1	4302	3520	73	48.1	5736
	BLUE	304	19	15.7	482	608	39	15.7	964	912	58	15.7	1446	1216	78	15.7	1928
	WHITE	892	20	44.8	1507	1784	40	44.8	3014	2676	60	44.8	4521	3568	80	44.8	6028
20° X 20°	RGB40	818	20	40.9	5150	1636	40	40.9	10300	2454	60	40.9	15450	3272	80	40.9	20600
	RED	229	16	14.7	1376	458	31	14.7	2752	687	47	14.7	4128	916	62	14.7	5504
	GREEN	951	18	52.0	5846	1902	37	52.0	11692	2853	55	52.0	17538	3804	73	52.0	23384
	BLUE	333	19	17.2	2141	666	39	17.2	4282	999	58	17.2	6423	1332	78	17.2	8564
	WHITE	977	20	49.1	6300	1954	40	49.1	12600	2931	60	49.1	18900	3908	80	49.1	25200
20° X 30°	RGB40	741	20	37.1	2461	1482	40	37.1	4922	2223	60	37.1	7383	2964	80	37.1	9844
	RED	203	16	13.0	664	406	31	13.0	1328	609	47	13.0	1992	812	62	13.0	2656
	GREEN	864	18	47.2	2850	1728	37	47.2	5700	2592	55	47.2	8550	3456	73	47.2	11400
	BLUE	303	19	15.6	1002	606	39	15.6	2004	909	58	15.6	3006	1212	78	15.6	4008
	WHITE	894	20	44.9	3013	1788	40	44.9	6026	2682	60	44.9	9039	3576	80	44.9	12052
20° X 60°	RGB40	727	20	36.4	1530	1454	40	36.4	3060	2181	60	36.4	4590	2908	80	36.4	6120
	RED	199	16	12.8	413	398	31	12.8	826	597	47	12.8	1239	796	62	12.8	1652
	GREEN	864	18	47.2	1768	1728	37	47.2	3536	2592	55	47.2	5304	3456	73	47.2	7072
	BLUE	295	19	15.2	618	590	39	15.2	1236	885	58	15.2	1854	1180	78	15.2	2472
	WHITE	867	20	43.6	1844	1734	40	43.6	3688	2601	60	43.6	5532	3468	80	43.6	7376
20° X 90°	RGB40	707	20	35.4	955	1414	40	35.4	1910	2121	60	35.4	2865	2828	80	35.4	3820
	RED	195	16	12.5	264	390	31	12.5	528	585	47	12.5	792	780	62	12.5	1056
	GREEN	820	18	44.8	1101	1640	37	44.8	2202	2460	55	44.8	3303	3280	73	44.8	4404
	BLUE	284	19	14.6	386	568	39	14.6	772	852	58	14.6	1158	1136	78	14.6	1544
	WHITE	841	20	42.3	1161	1682	40	42.3	2322	2523	60	42.3	3483	3364	80	42.3	4644
40° X 40°	RGB40	907	20	45.4	1667	1814	40	45.4	3334	2721	60	45.4	5001	3628	80	45.4	6668
	RED	292	16	18.7	551	584	31	18.7	1102	876	47	18.7	1653	1168	62	18.7	2204
	GREEN	1052	18	57.5	1966	2104	37	57.5	3932	3156	55	57.5	5898	4208	73	57.5	7864
	BLUE	364	19	18.8	667	728	39	18.8	1334	1092	58	18.8	2001	1456	78	18.8	2668
	WHITE	1069	20	53.7	1918	2138	40	53.7	3836	3207	60	53.7	5754	4276	80	53.7	7672
40° X 60°	RGB40	785	20	39.3	790	1570	40	39.3	1580	2355	60	39.3	2370	3140	80	39.3	3160
	RED	246	16	15.8	251	492	31	15.8	502	738	47	15.8	753	984	62	15.8	1004
	GREEN	922	18	50.4	934	492	31	15.8	502	2766	55	50.4	2802	3688	73	50.4	3736
	BLUE	319	19	16.4	319	638	39	16.4	638	957	58	16.4	957	1276	78	16.4	1276
	WHITE	937	20	47.1	936	1874	40	47.1	1872	2811	60	47.1	2808	3748	80	47.1	3744
40° X 90°	RGB40	937	20	47.1	936	1504	40	37.6	1130	2256	60	37.6	1695	3008	80	37.6	2260
	RED	937	20	47.1	936	470	31	15.1	358	705	47	15.1	537	940	62	15.1	716
	GREEN	879	18	48.0	664	1758	37	48.0	1328	2637	55	48.0	1992	3516	73	48.0	2656
	BLUE	303	19	15.6	227	606	39	15.6	454	909	58	15.6	681	1212	78	15.6	908
	WHITE	892	20	44.8	667	1784	40	44.8	1334	2676	60	44.8	2001	3568	80	44.8	2668
60° X 60°	RGB40	826	20	41.3	950	1652	40	41.3	1900	2478	60	41.3	2850	3304	80	41.3	3800
	RED	259	16	16.6	303	518	31	16.6	606	777	47	16.6	909	1036	62	16.6	1212
	GREEN	972	18	53.1	1151	1944	37	53.1	2302	2916	55	53.1	3453	1356	78	17.5	1628
	BLUE	339	19	17.5	407	678	39	17.5	814	1017	58	17.5	1221	1356	78	17.5	1628
	WHITE	997	20	50.1	1105	1994	40	50.1	2210	2991	60	50.1	3315	3988	80	50.1	4420

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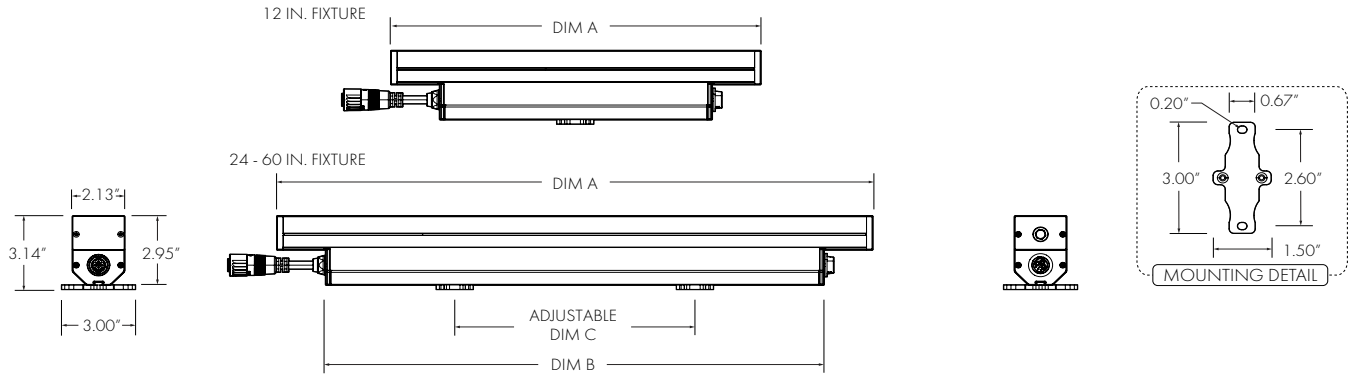
PROJECT: TYPE: FIXTURE CATALOG #: AP - - - - - - - - - -

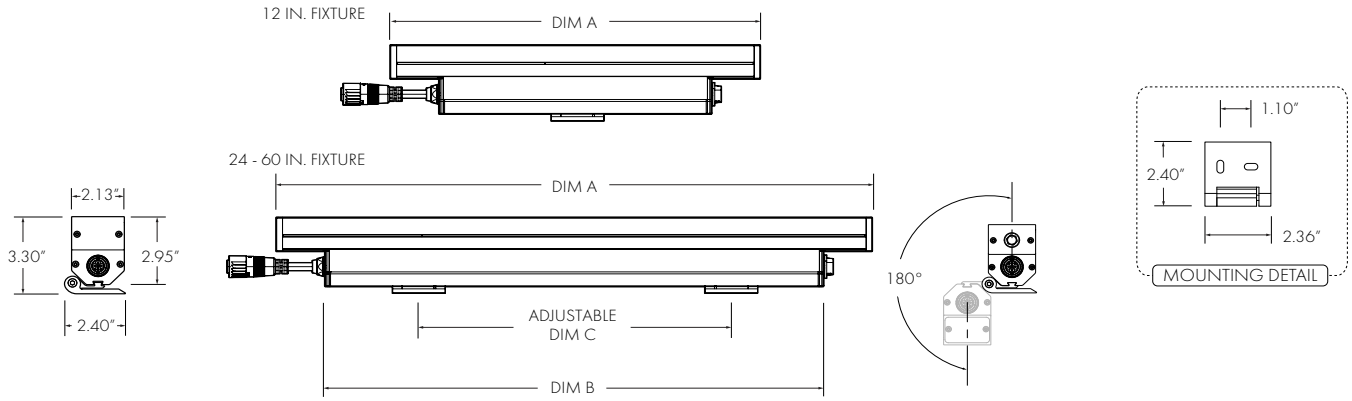
DIMENSIONS

DIMENSION	12.00"	24.00"	36.00"	48.00"	60.00"
DIM A	12.56"	24.37"	36.18"	48.00"	59.81"
DIM B	8.60"	20.24"	32.06"		55.68"
DIM C	NA	6.00" MIN | 12.00" MAX	12.00" MIN | 24.00" MAX	18.00" MIN | 30.00" MAX	24.00" MIN | 36.00" MAX

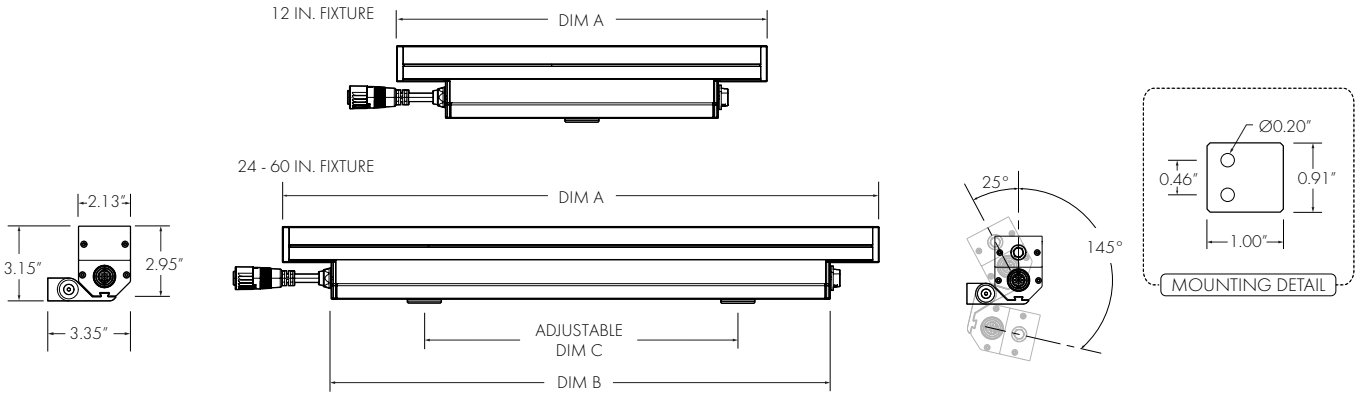
FIXED MOUNT (SA28170-1 / SA28170)



HINGE MOUNT (SA28104-1/ SA28104)



WALL MOUNT (SA28105-1 / SA28105)



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DIMENSIONS

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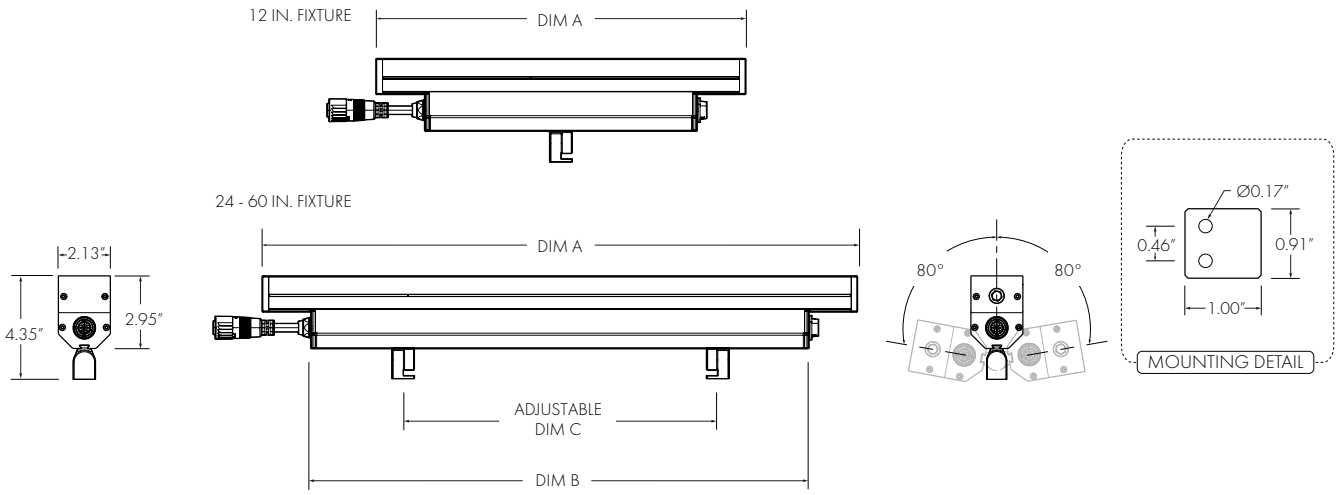
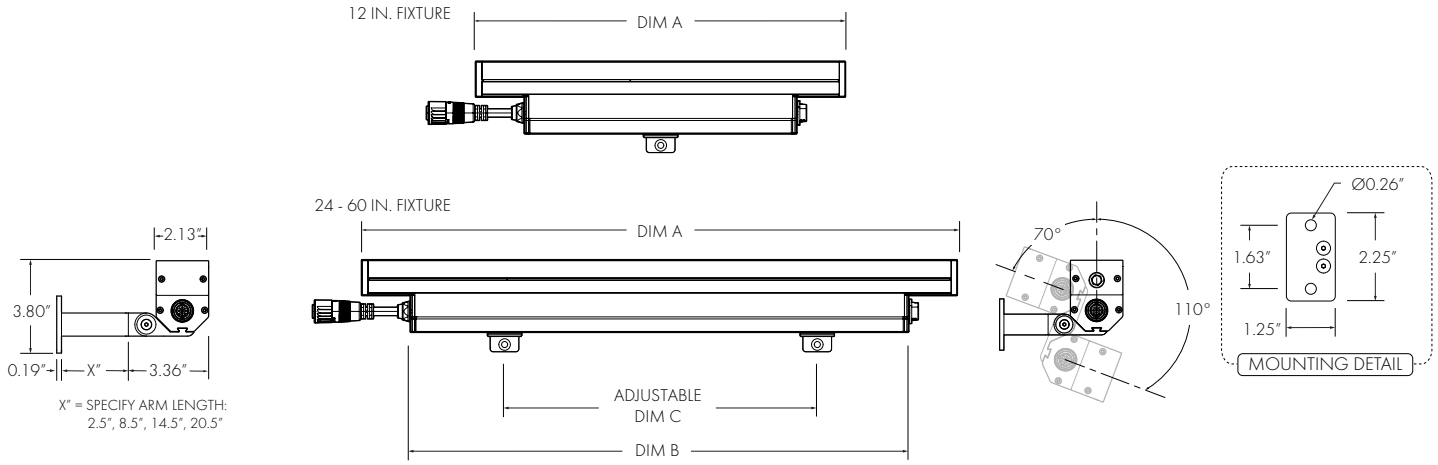
DIM A	12.56"	24.37"	36.18"	48.00"	59.81"
DIM B	8.60"	20.24"	32.06"		55.68"
DIM C	NA	6.00" MIN | 12.00" MAX	12.00" MIN | 24.00" MAX	18.00" MIN | 30.00" MAX	24.00" MIN | 36.00" MAX

GROUND MOUNT (SA28106-1/ SA28106)



EXTENDED ARM, WALL MOUNT (SA28107-1-X/ SA28107-X)



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DIMENSIONS

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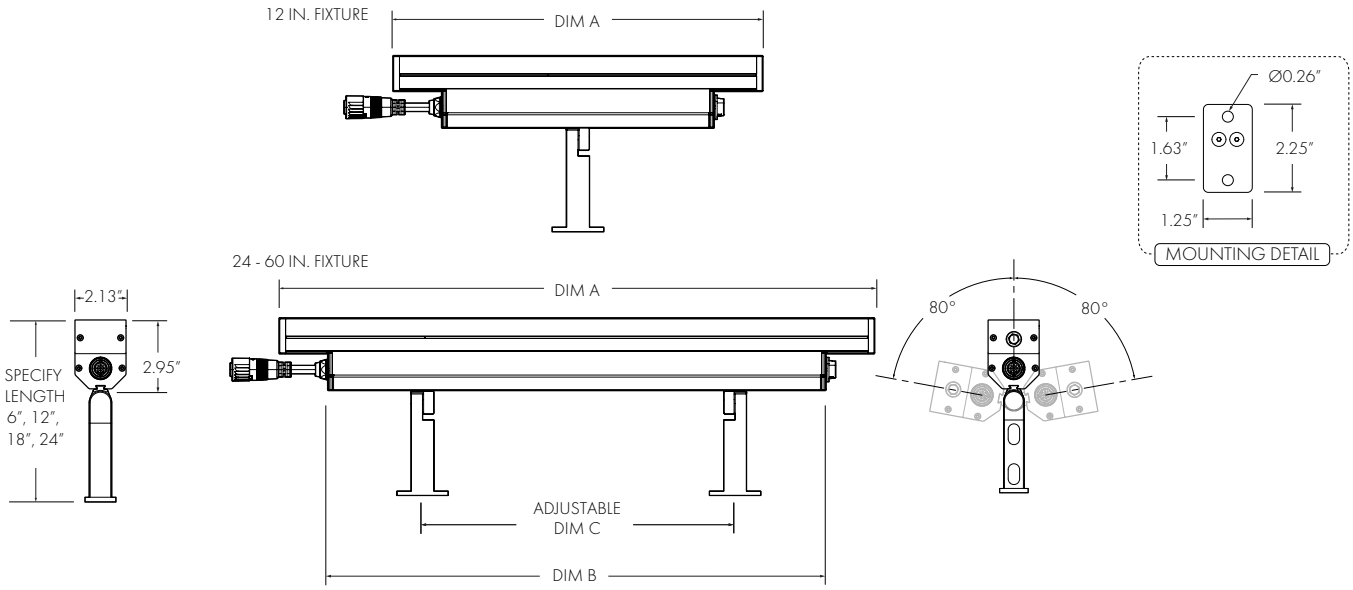
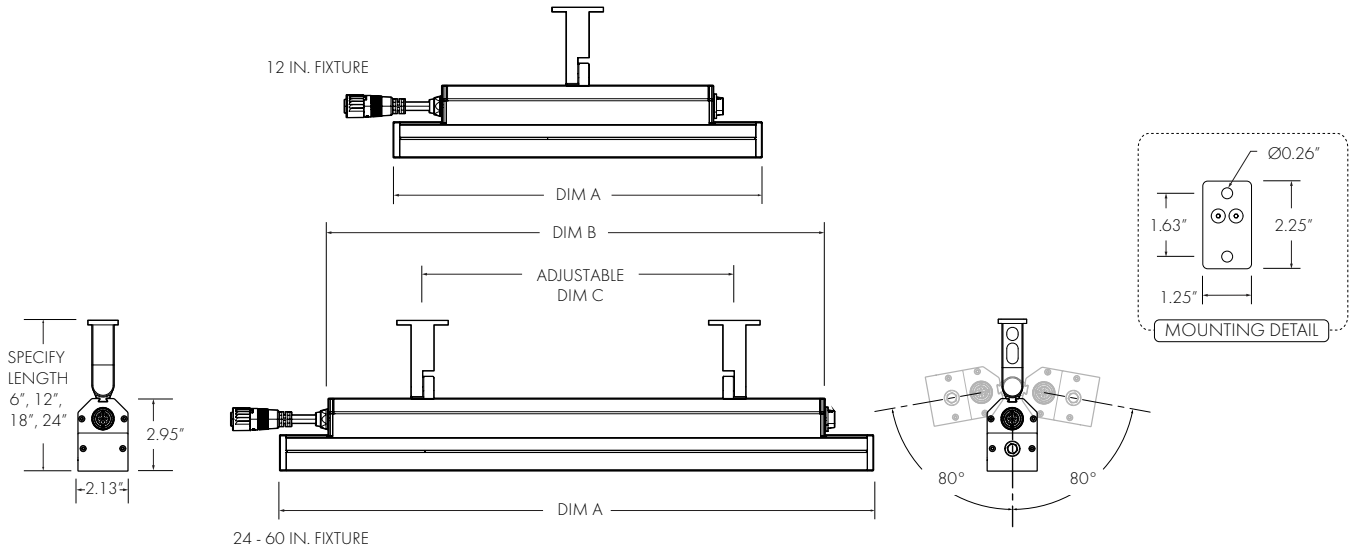
DIM A	12.56"	24.37"	36.18"	48.00"	59.81"
DIM B	8.60"	20.24"	32.06"		55.68"
DIM C	NA	6.00" MIN | 12.00" MAX	12.00" MIN | 24.00" MAX	18.00" MIN | 30.00" MAX	24.00" MIN | 36.00" MAX

EXTENDED ARM, GROUND MOUNT (SA28108-1-X/ SA28108-X)



PENDANT MOUNT (SA28108-1-X/ SA28108-X)



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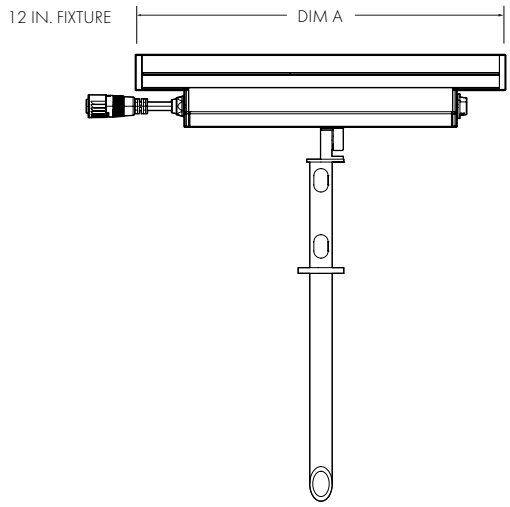
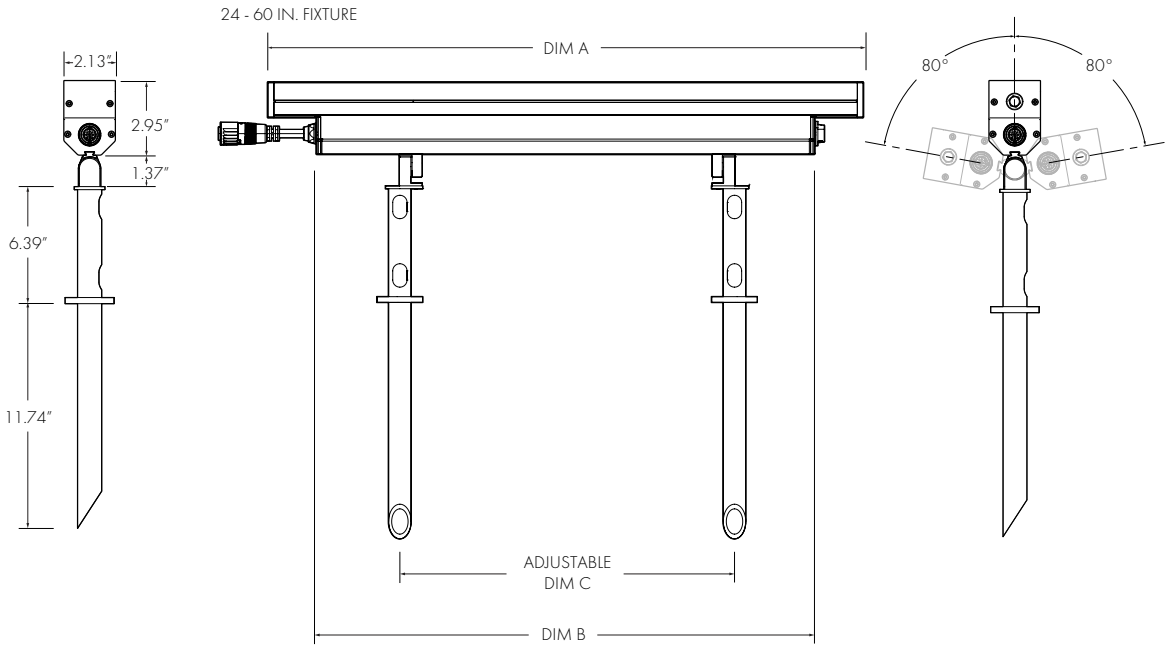
PROJECT: TYPE: FIXTURE CATALOG #: AP - - - - - - - - - -

DIMENSIONS

DIMENSION	12.00"	24.00"	36.00"	48.00"	60.00"
DIM A	12.56"	24.37"	36.18"	48.00"	59.81"
DIM B	8.60"	20.24"	32.06"		55.68"
DIM C	NA	6.00" MIN | 12.00" MAX	12.00" MIN | 24.00" MAX	18.00" MIN | 30.00" MAX	24.00" MIN | 36.00" MAX

STAKE MOUNT (SA28110-1/SA28110)





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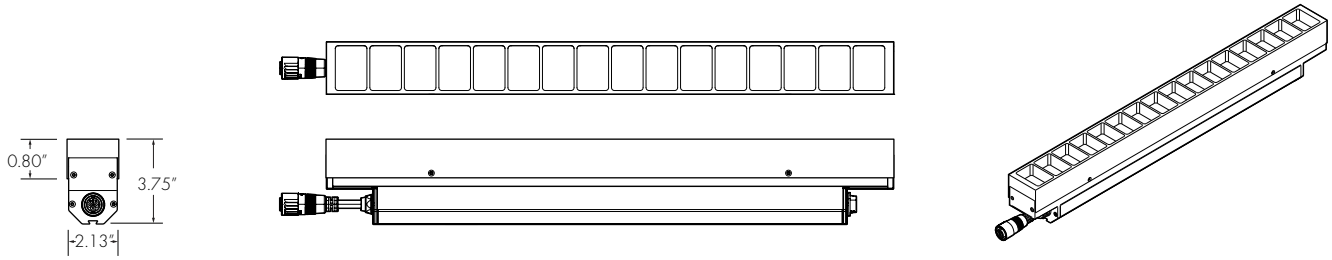
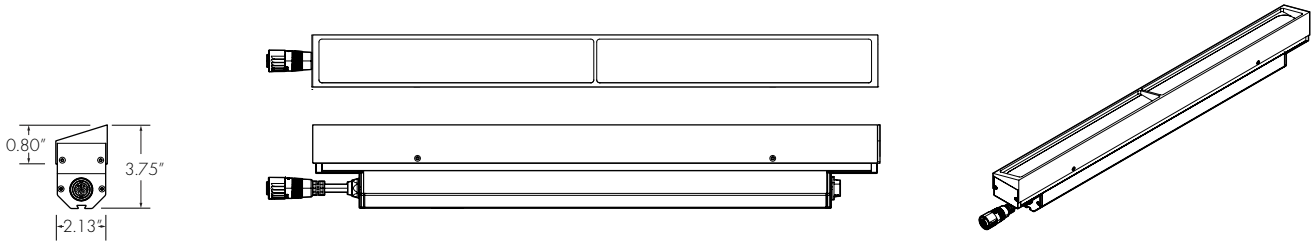
SHIELDING ACCESSORIES

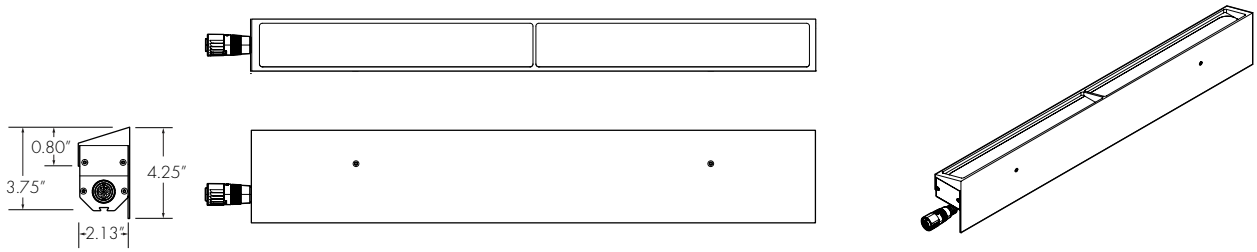
LOUVER (SA28111-X)



VISOR (SA28112-x)



SHIELD (SA28113-x)



insight lighting
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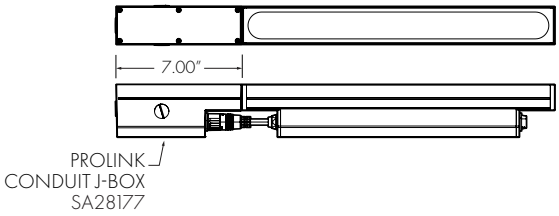
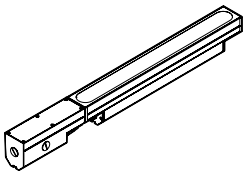
P.: 505.345.0888 | insightlighting.com

PROJECT: TYPE: FIXTURE CATALOG #: AP - - - - - - - - - -

PROLINK TECHNOLOGY

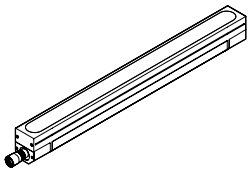
PROLINK CONDUIT J-BOX



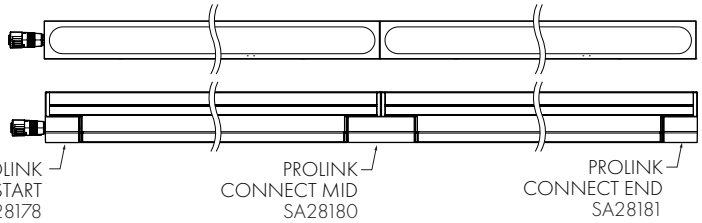


PROLINK CONNECT - WIRE COVER

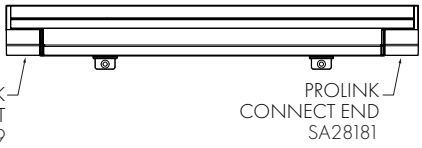
SINGLE FIXTURE

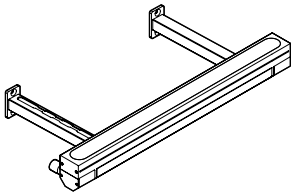


CONTINUOUS RUN



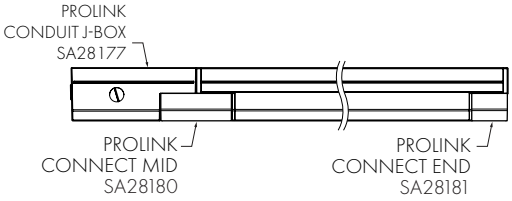
EXTENDED ARM
WALL MOUNT



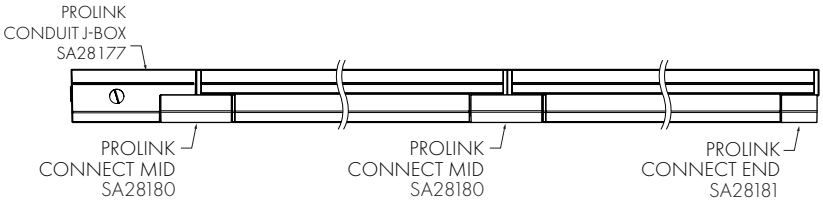


EXAMPLE OF PROLINK CONDUIT BOX AND CONNECT

SINGLE FIXTURE



CONTINUOUS RUN



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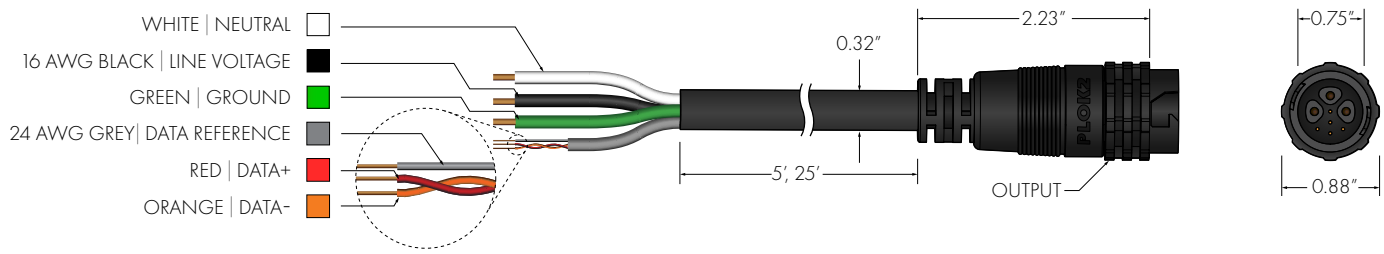
PROJECT: TYPE: FIXTURE CATALOG #: AP - - - - - - - - - -

CABLES

LEADER (EL12430-X-X)

BLACK | 3x16AWG | 3X24AWG | 105°C | 600V | IP67

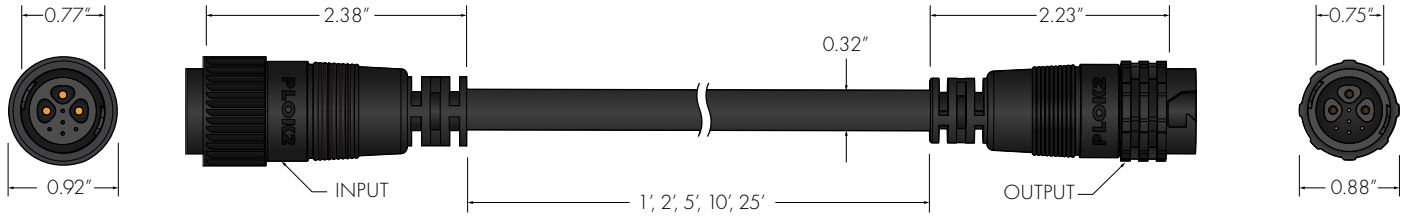


LEADER CABLES - REQUIRED	
5.0 FT LEADER CABLE, BLACK	EL12430-5-B
10.0 FT LEADER CABLE, BLACK	EL12430-10-B

LEADER CABLES - REQUIRED	
5.0 FT LEADER CABLE, WHITE	EL12430-5-W
10.0 FT LEADER CABLE, WHITE	EL12430-10-W

JUMPER (EL12288-X-X)

BLACK | 3x16AWG | 3x24AWG | 105°C | 600V | IP67

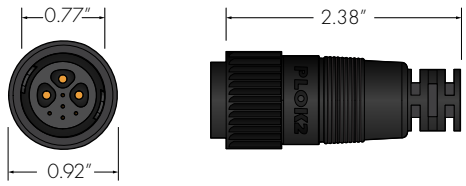


EXTERIOR JUMPER CABLES FOR PLUG AND PLAY SYSTEMS - OPTIONAL	
1.0 FT JUMPER CABLE, BLACK	EL12288-1-B
2.0 FT JUMPER CABLE, BLACK	EL12288-2-B
5.0 FT JUMPER CABLE, BLACK	EL12288-5-B
10.0 FT JUMPER CABLE, BLACK	EL12288-10-B
25.0 FT JUMPER CABLE, BLACK	EL12288-25-B

EXTERIOR JUMPER CABLES FOR PLUG AND PLAY SYSTEMS - OPTIONAL	
1.0 FT JUMPER CABLE, WHITE	EL12288-1-W
2.0 FT JUMPER CABLE, WHITE	EL12288-2-W
5.0 FT JUMPER CABLE, WHITE	EL12288-5-W
10.0 FT JUMPER CABLE, WHITE	EL12288-10-W
25.0 FT JUMPER CABLE, WHITE	EL12288-25-W

DMX TERMINATOR (EL12291-X)

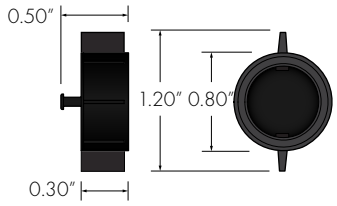
BLACK | 105°C | 600V



DMX TERMINATOR - ONE REQUIRED PER DMX RUN	
DMX TERMINATOR, BLACK	EL12291–B
DMX TERMINATOR, WHITE	EL12291–W

AC CAP (EL11900-X)

BLACK | 105°C | 600V | IP67



AC CONNECTOR CAP - REQUIRED FOR NO DIMMING/0-10V DIMMING	
CONNECTOR CAP, BLACK	EL11900–B
CONNECTOR CAP, WHITE	EL11900–W

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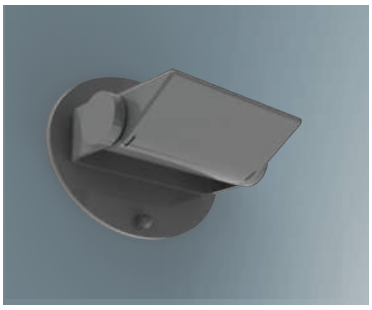
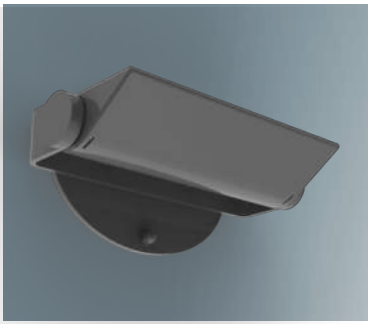
P.: 505.345.0888 | insightlighting.com

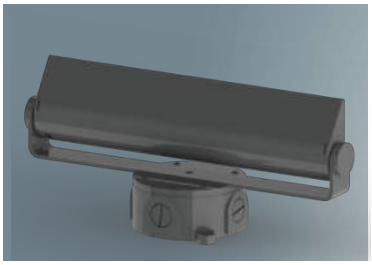
Style S159

XtraSmall Outdoor with remote driver

George R. Brown Convention Center | Lighting Design: Lighting Design Alliance | Photography: Jonnu Singleton







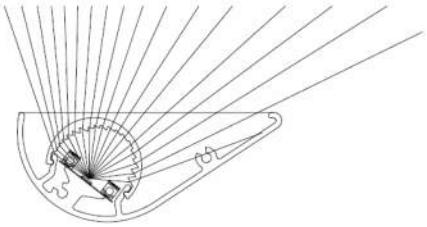
Features

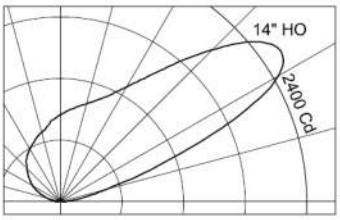
- Small yet powerful 2.8” x 1.8”, up to 3513 delivered lumens
- **IP68** ingress protection
- **IK10** impact rating
- Marine Grade finish, complies with1000 hour salt spray
- All aluminum and stainless steel construction
- Static white (3000K, 3500K, 4000K), Dim-to-Warm, Tunable White or RGBW

Performance

Precisely extruded acrylic lens produces an asymmetric distribution ideal for illuminating vertical surfaces evenly from top to bottom

For LM79 and photometric reports, visit **thelightingquotient.com**





L85(17k) > 104,000
hrs. @ 25°C per TM-21

114 Boston Post Road, West Haven, Connecticut 06516, USA
Voice 203-931-4455

S159

elliptipar®

PROJECT	TYPE

S159 _ _ _ _ _ _ _ _ _ _ **CATALOG NUMBER**

1 2 3 4 5 6 7 8 9 10

1 STYLE

S159 = Outdoor point source adjustable asymmetric uplight with remote driver

2 OUTPUT / POWER

S = Standard output
H = High output

3 LENGTH

ORDER CODE	LENGTH	LUMENS	INPUT WATTS
S-**04**	04"	470	5
S-**08**	08"	939	7
S-**14**	14"	1877	15
H-**04**	04"	859	10
H-**08**	08"	1717	15
H-**14**	14"	3435	30

Based on 3500K, 90+CRI *See* ***Scaled Performance Table***

4 MOUNTING

E = Yoke with flat canopy over recessed outlet box (by others)
S = Yoke with flat canopy and round outdoor surface junction box for direct feed from sides or top finish to match fixture.
X = Yoke mounted for use with ACJ cantilever

5 FINISH ** non-cancellable/non-returnable*

02 = Semigloss White
06 = Dark Bronze*
07 = Silver*
08 = Semigloss Black
13 = Matte Black*
15 = Metallic*
17 = Champagne*
18 = Copper*
22 = Matte White*
PL = Platinum*
99 = Custom or RAL (Consult Rep.)

6 VOLTAGE

M = 120-277V Universal voltage input

7 OPTIONS *(see Accessories Section for specifications)*

00 = Standard output
0B = Cross baffle, provides 25° lateral shielding
0D = Indoor remote driver

8 DESTINATION REQUIREMENT

0 = CSA certified for U.S.
J = CSA certified for Canada

9 COLOR TEMPERATURE / CRI

930 = 3000K, 90+ CRI
935 = 3500K, 90+ CRI
940 = 4000K, 90+ CRI
D2W = Dim-to-Warm 2200K-3000K, 90+ CRI, other CCTs available
TWH = Tunable White; 2700K-6500K, 90+ CRI
RGB = Color Tunable; RGBW with 3500K, 90+ CRI white

NOTE: *Additional CCT and CRI options are available; consult factory.*

10 DIMMING

00 = Non-dimming
ZX = 0-10V analog dimming 120-277V or 347V input, dimming 100%-1%, 0-10V controls by others
TD = ERP forward or reverse phase 120V only, dimming 100%-6%, 120V phase controls by others
EL = 0-10V eldoLED SOLOdrive, 120-277V input, dimming100%-0.1%, 0-10V controls by others
ED = DALI eldoLED SOLOdrive, 120-277V input, dimming100%-0.1%, DALI controls by others
DZ = D2W or TWH 2-Channel driver for use with 0-10V controls by others
DD = D2W or TWH 2-Channel DALI driver (DALI controls by others)
DA = RGBW 4-Channel DMX module (DMX controls by others) DM = RGBW 4-Channel eldoLED LINEARdrive (DMX controls by others)

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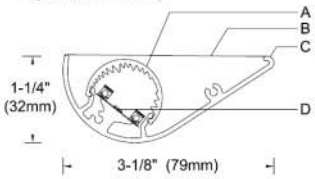
S159

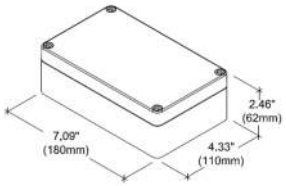
XtraSmall Outdoor with Remote Driver

Optical Assembly

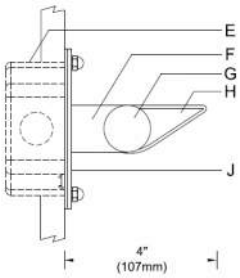


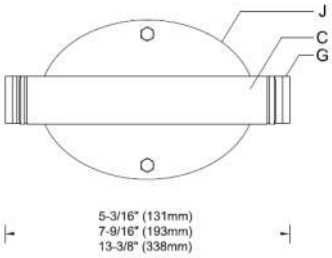
Remote Driver Enclosure

See remote LED driver document MA-1501 for dimensions, wiring, mounting instructions

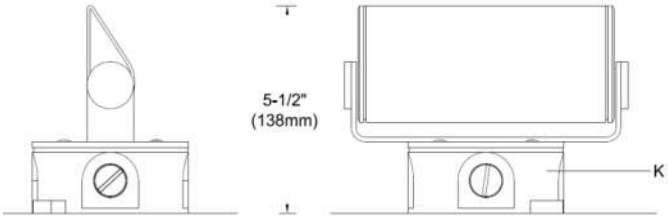


Wall Mounted

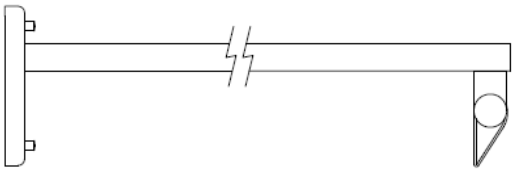




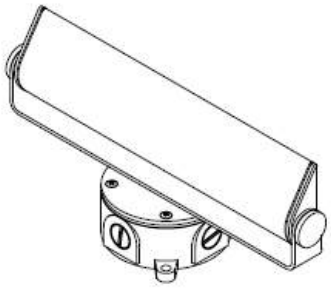
Base Mounted



Cantilever Mounted



A	Extruded asymmetric distribution lens
B	Aluminum end plate
C	Extruded aluminum housing
D	High efficiency LED array
E	Recessed junction box (by others)
F	Formed aluminum yoke
G	Machined aluminum knob
H	Machined aluminum decorative end cap
J	Aluminum mounting plate and canopy
K	Die cast aluminum surface junction box



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Voice 203-931-4455

S159

Specifications

Housing and Optic Assembly:
Extruded aluminum heat sink/optic housing. Heat sink anodized for maximum emissivity. Precision extruded polymer refractive lens with optimal diffusion.

Finish:
Extruded aluminum heat sink/housing, aluminum reveal plates and end plates finished white, black or custom color. Formed aluminum canopy, end hubs and stems painted white or black. Painted surfaces – 6 stage pretreatment and electrostatically applied thermoset polyester powder coating for a durable abrasion, fade and corrosion resistant finish, complies with UL1598A Marine grade finish. All hardware – stainless steel or nickel plated brass.

Mounting:
E-mount formed aluminum yoke with flat canopy mounts over recessed outlet box (by others).
S-mount formed aluminum yoke with flat canopy and round outdoor surface box for direct feed from sides or rear.
X-mount formed aluminum yoke mounts to pendant or cantilever accessory (ordered separately). Fixture weight: 4”=1.5 lbs (0.7 kg); 8”=1.8 lbs (0. 8 kg); 14”=2.5 lbs (0.9 kg)

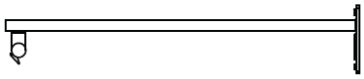
Electrical:
Luminaire furnished with 10 foot (3048mm) SJOOW cord for connection to remote driver. Electronic HPF thermally protected Class II driver mounted in weather-proof enclosure or optional indoor dry enclosure. For complete driver specifications, see website, reference document *MA-1501.*

Standard:
CSA certified for wet locations
Ingress rating: IP68,
Impact rating: IK10
Marine Grade Finish: 1000 hour salt spray per ASTM B117
5 year warranty
Maximum ambient temperature 45°C (113°F).

Required Mounting Hangers

Lighting The Vertical
Required **ACJ** cantilever hanger for mount are ordered and priced separately. See installation sheets on website.

ACJ — **30** = **Cantilever**, *30" (760mm) setback (for use with* **X***-mount)*
O = *U.S.*
J = *Canada*
5 Finish



AMS — **000** = **Surface mount** *splice box for use with ACJ cantilever*
5 Finish

Controls

LiQ luminaires are compatible with a wide variety of wired and wireless controls and sensors. See ***Controls Information***.

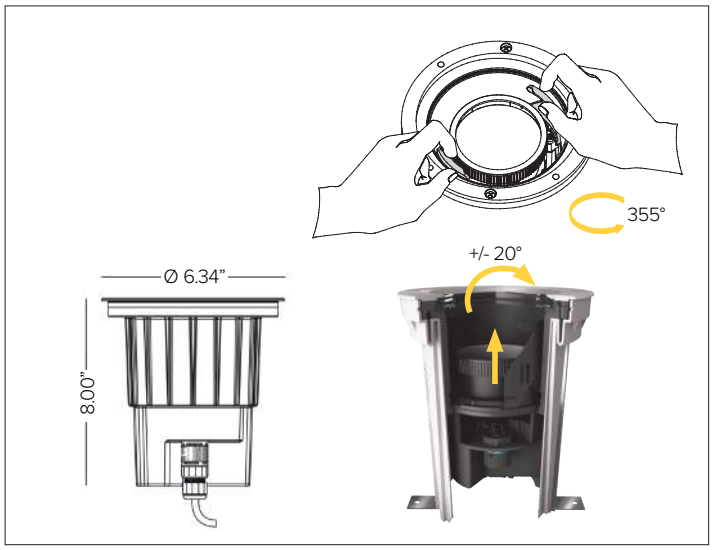
AWB-TP-DMX-0 = RGBW LED dimmer switch fits in a standard wall switch box and provides on/off control as well as fixed levels of dimmability. The dimmer switch has a color-selection wheel for thousands of color options, 10 dynamic color-changing/single color modes, 0-100% dimming, on/off controls, and 4 color-specific channel controls for red, green, blue, and white.

Additional wired and wireless controls available, see ***Driver and Controls Information***.

KEPLERO MINI ZOOM

Professional Inground LED Fixture

KEPLERO® MINI ZOOM with brushed natural trim and clear lens



QS | Marine[A] | RoHS3 Compliant | Drive Over | Cool Touch | IP69K | IP68 | c UL us

CONCEPT

Professional fully adjustable landscape inground fixture. As landscaping matures and changes overtime the zoom optic can be manually adjusted to adapt with the ever changing landscape conditions.

MECHANICAL CHARACTERISTICS

Housing	8"H x 6.34"Dia. Housing.
Materials	Anodized marine grade cataphoresis[A] die-cast aluminum heat sink body with PVC installation sleeve. AISI316L stainless steel trim ring with beveled edge with extra clear glass lens.
Finish	Brushed Natural · Bronze PVD* · Black PVD*
	*Physical Vapor Deposition.
Power Connection	Provided with 4ft SJ00W 16-6 cable and DSMT anti-wicking quick disconnect to direct burial brass ingrade jbox (required, sold separately).
Functionality	Adjustable +/-20° on the vertical axis and rotated 355° on the horizontal axis with friction locking mechanism.
Mounting	Flush, semi-flush or raised tube mountings. Installation sleeve for flush or semi-flush mountings includes optional stainless steel 'L' brackets for additional mounting support. Fixture equipped with fastening holes and stainless steel screws for attachment into installation sleeve assembly.
Weight	2.43lbs
Protection	IP68[B] / IP69K
Impact	IK10
Load	Resistant to static loads up to 4,496lbs in flush mounted cement and pavement installations.

CERTIFICATIONS

cULus Class2 Wet Location Listed.
Tested in accordance with LM-79-08.
Compliant for California installations.
IEC 62471
RoHS3 EU 215/863

SUSTAINABILITY

Luminaire designed for disposal/recycling at end-of-life. Replaceable LED light source and control gear by a Targetti technician.

ELECTRICAL CHARACTERISTICS

Power Supply	Integral 4/1 smart driver (Non-Dimmable / 0-10V / Reverse Phase / Forward Phase).
Wattage	14W
Voltage	Universal Voltage 120-277V AC 50/60Hz
Ambient Temp.	-25°C / +35°C (95°F)

SOURCE

High efficiency LED Chip on Board.

TM30	*CCT (Nominal)*	*CRI*	*Rf*	*Rg*	*SDCM*
	2700K	80	82	96	2
	3000K	80	83	96	2
	3500K	80	83	95	2
	4000K	80	82	95	2

Ra90 available upon request

OPTIC

Zoom optical system manually slides and locks on vertical axis collimating the optic to four different fixed beam positions (SP / FL / MWFL / WFL).

Beam		*SP 15°*	*FL 32°*	*MWFL 53°*	*WFL 61°*
Delivered Lumens	***2700K***	627Lm	831Lm	1,073Lm	1,158Lm
	3000K	661Lm	876Lm	1,132Lm	1,221Lm
	4000K	669Lm	887Lm	1,146Lm	1,236Lm

For 3500K lumen values use multiplier of 1.01 from 3000K.

Efficacy	95Lm/W max. Refer to photometric graphs for specific values.
Lifetime	L95/B10 30,000hrs at max TA +25°C L94/B10 50,000hrs at max TA +25°C
Photobiological Classification	Low risk safety RG1

WARRANTY

5 year limited warranty.

[A] Fixture body complete with marine grade cataphoresis suitable for use in marine grade environments. Stainless steel trim will need to be maintained and cleaned regularly to avoid mineral deposits. Not to be in direct contact with salt or corrosive agents for extended periods of time.

[B] Temporary immersion up to 24 hours at a max depth of 2 meters. Installation of fixture requires proper drainage to prevent any standing water. Should not be used for permanent submersion.

KEPLERO MINI ZOOM

SPECIFICATION INFORMATION

KPLM	41	ZM			/	/	/	/
1	2	3	4	5	6	7	8	9

Ex: KPLM41ZML227 / 1E2525 / 1DU2521 / 1DU2530

REQUIRED — OPTIONAL

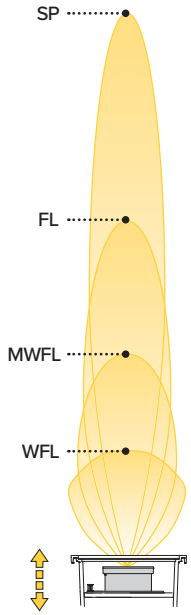
1 - PRODUCT CODE	2 - DRIVER	3 - TYPE	4 - WATTAGE	5 - KELVIN
KPLM — KEPLERO MINI	**41** – 4/1 Smart Dimming *(Non-Dimming / 0-10V / Reverse Phase / Forward Phase)*	**ZM** – Zoom	**L2** — 14W	**27** — 2700K **30** — 3000K **35** — 3500K **40** — 4000K

6 - TRIM	7 - INSTALLATION	8 - INSTALLATION ACCESSORIES	9 - OPTICAL ACCESSORIES
Round Trim Ring *See section for details*	Flush Mount Sleeve *See section for details*	Torx Key *See section for details*	Blade of Light Linear Spread Lens *See section for details*
Square Trim Ring *See section for details*	Raised Tube *See section for details*	Fixture Removal Tool *See section for details*	Anti Glare Honeycomb Louver *See section for details*
	Junction Box *See section for details*	Glass Removal Tool *See section for details*	Half Moon Anti Glare Shutter *See section for details*

For applicable quick ship items, see model configurations listed below. Lead time for quick ship fixtures is 1-2 weeks from processed PO date. Consult factory for quantities of over 20pcs to confirm lead time.

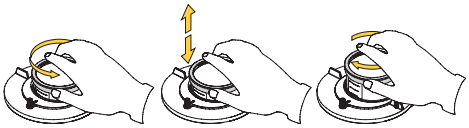
QS **QSKPLM41ZML230 + 1E2525 + 1DU2521 + 1DU2530**

OPTICAL SYSTEM



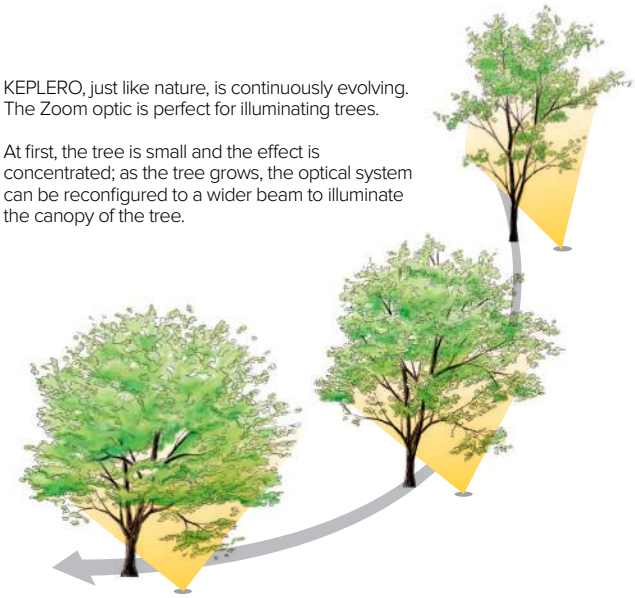
Zoom is a patented optical system that allows variation of the beam opening by manually moving the optical chamber.

Three simple movements - extraction, translation and rotation - it is possible to vary the beam opening from SP to WFL. Graduated rings help to recognize the adjustment allowing for easy repetition.



KEPLERO, just like nature, is continuously evolving. The Zoom optic is perfect for illuminating trees.

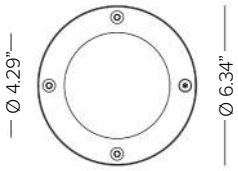
At first, the tree is small and the effect is concentrated; as the tree grows, the optical system can be reconfigured to a wider beam to illuminate the canopy of the tree.



KEPLERO MINI ZOOM

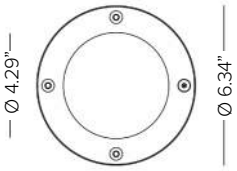
6 - TRIM (REQUIRED)

ROUND TRIM RING



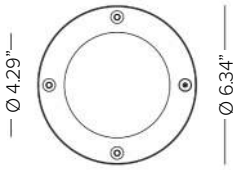
Round stainless steel (AISI316L) decorative ring. 10mm thick extra clear protective glass. Silicone gasket. Tamper proof (AISI316L) Torx screws.

Finish	Brushed Natural	Bronze PVD	Black PVD
Part No.	**1E2525**	**1DU2525B**	**1DU2525K**



Round stainless steel (AISI316L) decorative ring with anti-slip glass. 10mm thick extra clear protective glass. Silicone gasket. Tamper proof (AISI316L) Torx screws.

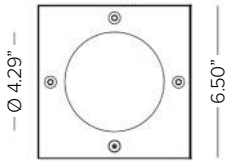
Finish	Brushed Natural	Bronze PVD	Black PVD
Part No.	**1DU2525A**	**1DU2525BA**	**1DU2525KA**



Round stainless steel (AISI316L) decorative ring with half frosted glass. 10mm thick extra clear protective glass. Silicone gasket. Tamper proof (AISI316L) Torx screws.

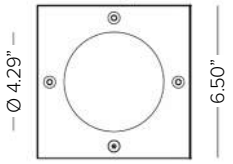
Finish	Brushed Natural	Bronze PVD	Black PVD
Part No.	**1DU2525E**	**1DU2525BE**	**1DU2525KE**

SQUARE TRIM RING



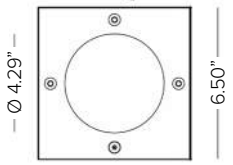
Square stainless steel (AISI316L) decorative ring. 10mm thick extra clear protective glass. Silicone gasket. Tamper proof (AISI316L) Torx screws.

Finish	Brushed Natural
Part No.	**1E2526**



Square stainless steel (AISI316L) decorative ring. 10mm thick extra clear protective glass. Silicone gasket. Tamper proof (AISI316L) Torx screws.

Finish	Brushed Natural
Part No.	**1DU2526A**

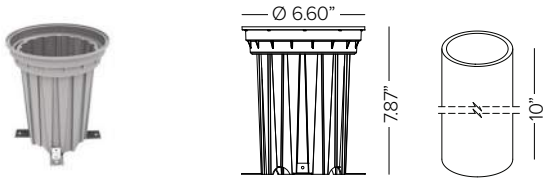


Square stainless steel (AISI316L) decorative ring. 10mm thick extra clear protective glass. Silicone gasket. Tamper proof (AISI316L) Torx screws.

Finish	Brushed Natural
Part No.	**1DU2526E**

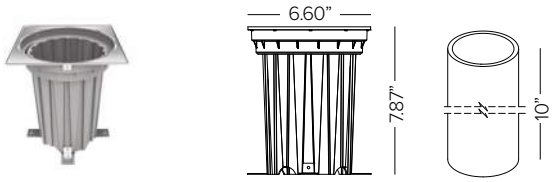
KEPLERO MINI ZOOM

7 - INSTALLATION (REQUIRED)



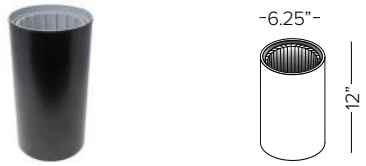
Installation sleeve for concrete pour applications. Grey Nylon casing with PVC installation outer pipe. For flush or semi-flush installations. **Required for use with 1DU2530 by NEC.**

Part No. **1DU2521**



Installation sleeve for concrete pour applications. Grey Nylon casing and stainless steel profile with PVC installation outer pipe. Square ring for flush installation only. **For use with square trim options only. Required for use with 1DU2530 by NEC.**

Part No. **1DU2522**



At grade or raised installation sleeve for turf or ground cover applications. 12”H stainless steel, includes factory pre-installed inner PVC installation sleeve. **To be used with round trim options only. Not suitable for use with 1DU2521 or 1DU2522.** (Field cuttable. Used for fixture elevations at grade to 3” above grade). **Required for use with 1DU2530 by NEC.**

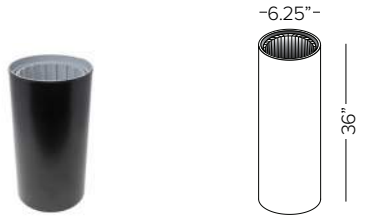
Finish ● Deep Black

Part No. **1DU4344-12**

Raised installation sleeve for ground cover (succulents and low level planting) applications. 18”H stainless steel, includes factory pre-installed inner PVC sleeve. **To be used with round trim options. Not suitable with 1DU2521 or 1DU2522.** (Field cuttable. Used for fixture elevation 7” above grade). **Required for use with 1DU2530 by NEC.**

Finish ● Deep Black

Part No. **1DU4344-18**



Raised installation sleeve for landscape applications. 36”H stainless steel, includes factory pre-installed inner PVC sleeve. **To be used with round trim options. Not suitable with 1DU2521 or 1DU2522.** (Field cuttable. Used for fixture elevation 21” above grade). **Required for use with 1DU2530 by NEC.**

Finish ● Deep Black

Part No. **1DU4344**

Direct burial brass ingrade j-box. Features stainless steel cover screws and strain relief for power cord, (2) 3/4” NPT bottom holes and (2) 3/4” NPT side holes. Includes (4) 3/4” to 1/2” adapters and (2) 1/2” NPT plugs. **(REQUIRED by NEC).**

Part No. **1DU2530**

8 - INSTALLATION (OPTIONAL)

Fixture metal maintenance removal handle. Helpful one per 10 fixtures.

Part No. **1E2524**

Anti-vandal torx head. Helpful one per 5 fixtures.

Part No. **1E2495**

Glass suction removal tool. Helpful one per 20 fixtures.

Part No. **1E0388**

KEPLERO MINI ZOOM

9 - OPTICAL ACCESSORIES (OPTIONAL)

MAXIMUM OF ONE OPTICAL FILTER OR LOUVER ACCESSORY PER FIXTURE

'Blade of Light' linear spread lens. Parallel ribbed glass.

Part No. **1T1708**

Anti-glare honeycomb louver with lacquered metal structure.

Finish ● Deep Black

Part No. **1T1711**

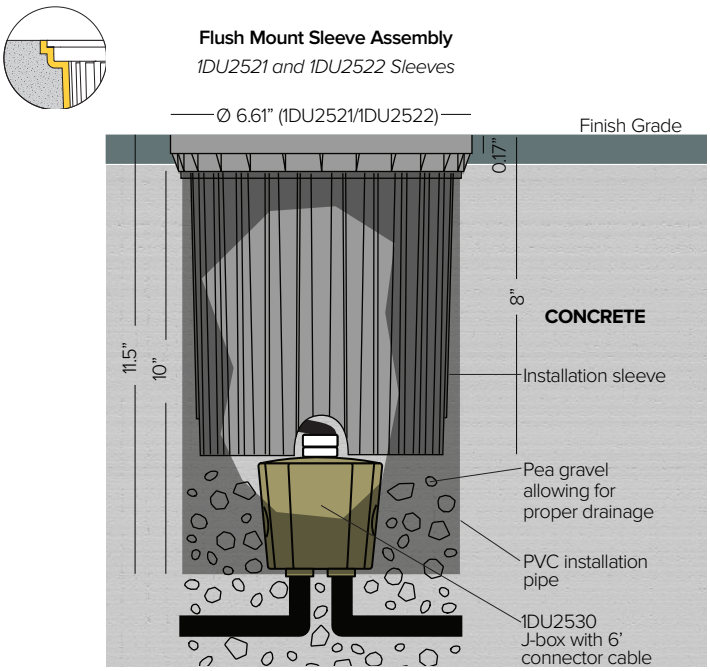
Integral half moon anti glare shutter. **Can be used as one per fixture with a filter or louver, not considered as part of the maximum optical accessories.**

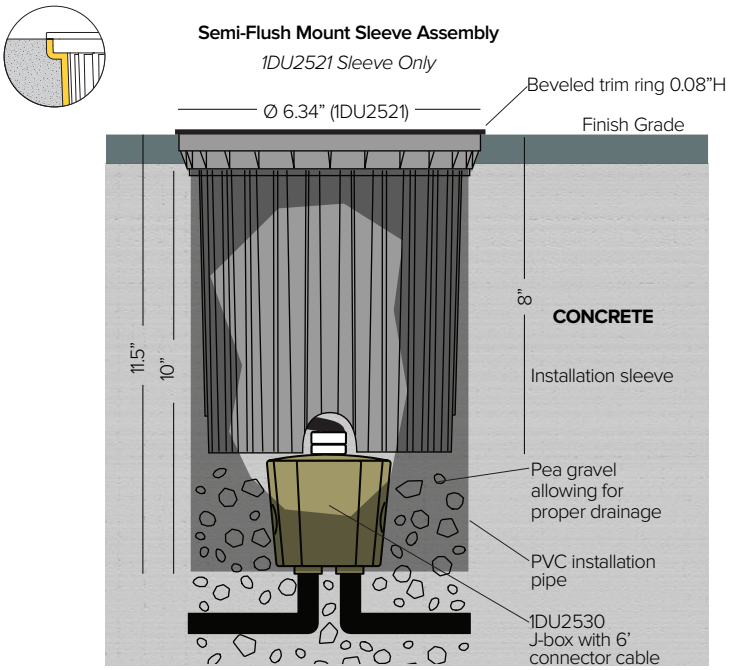
Finish ● Deep Black

Part No. **1E2523**

INSTALLATION DIAGRAM

CONCRETE POUR APPLICATION





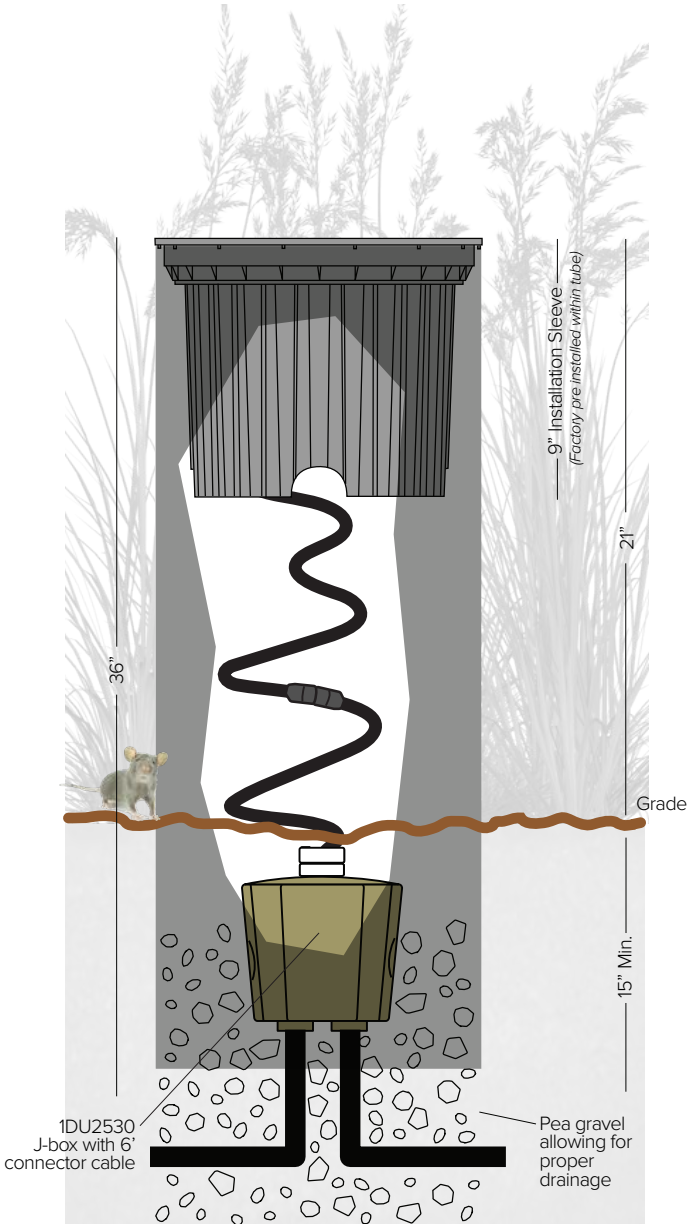
KEPLERO MINI ZOOM

INSTALLATION DIAGRAM

LANDSCAPE APPLICATION

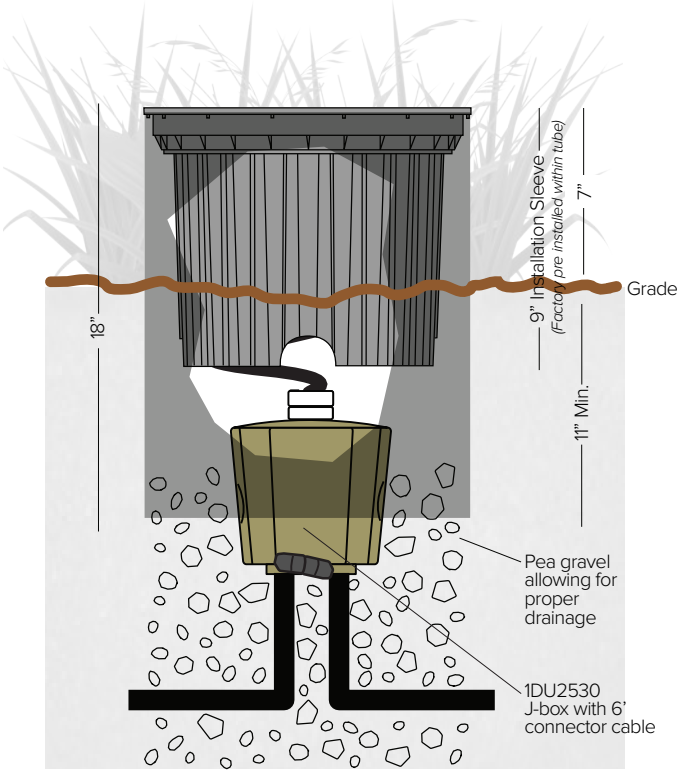
RAISED TUBE INSTALLATION ASSEMBLY

Recommended for Landscape Installation
1DU4344 with Round Trim ONLY



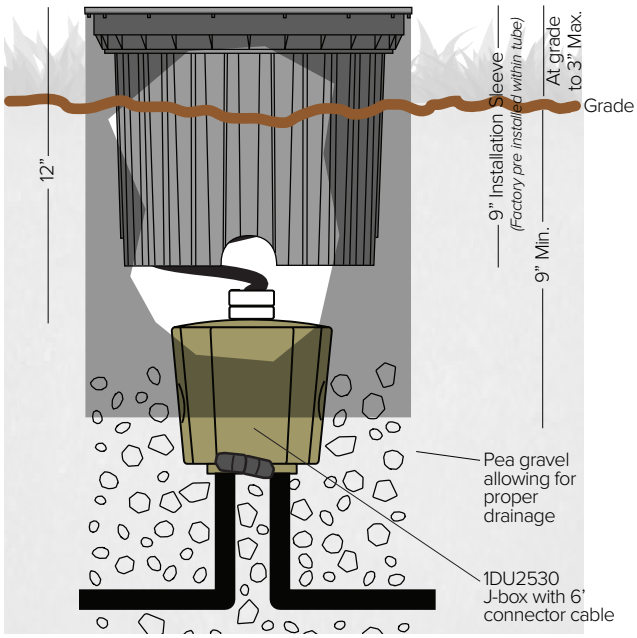
RAISED TUBE INSTALLATION ASSEMBLY

Recommended for Ground Level Installation
1DU434418 with Round Trim ONLY



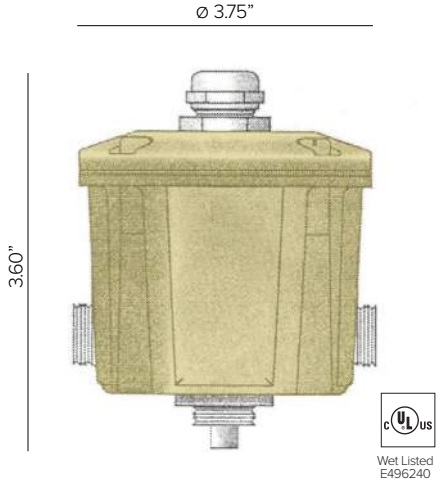
RAISED TUBE INSTALLATION ASSEMBLY

Recommended for Turf Installation
1DU434412 with Round Trim ONLY



KEPLERO MINI ZOOM

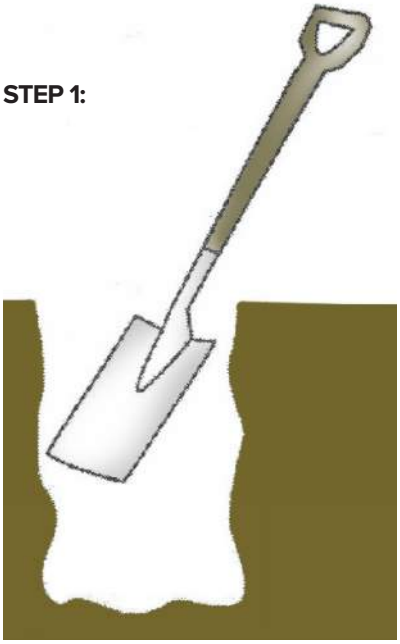
INSTALLATION DIAGRAM - 1DU2530 J-Box



Brass junction box is supplied with the following components:
(4) ¾” side/bottom NPT holes
(4) ½” reduction NPT adapters
(2) ½” cap plugs

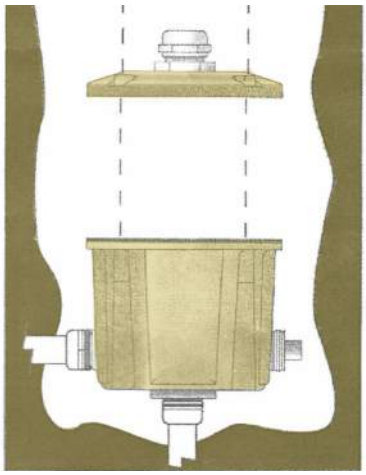
NOTE: Box fill size = 15.94 IN^3

STEP 1:



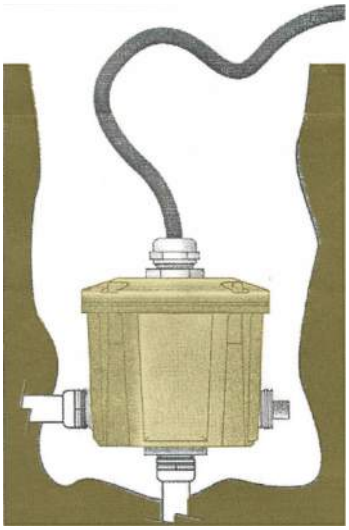
Dig a hole large enough to accommodate the junction box.

STEP 2:



Connect brass junction box to conduit system. Seal conduit entries inside junction box with a good grade RTV sealant per sealant manufacturer’s instructions.
Note: Drainage must be in place below junction box.

STEP 3:

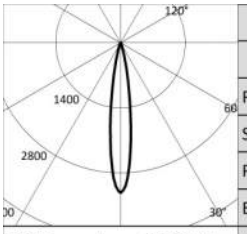


Seal threads. Tighten locking screw on bottom of cover. Connect all wires observing polarity (i.e. green-to-ground, white-to-common, and black-to-voltage). Provided with 1/2” strain relief.

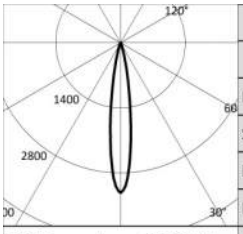
KEPLERO MINI ZOOM

PHOTOMETRY

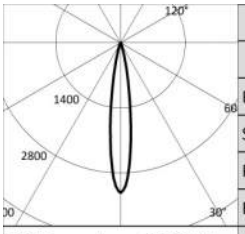
SPOT



2700K		H(m)	D(m)	Emax(lx)
Ra80			15°	
Fixture Power	14W	1	0.27	5870
Source Flux	1823lm	2	0.54	1467
Fixture Flux	627lm	3	0.82	652
Efficacy	46lm/W	4	1.09	367
TS815 Imax=3220cd/klm	Imax	5870cd	5	1.36	235

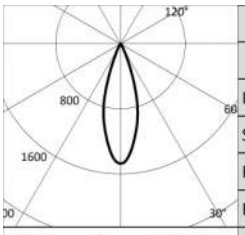


3000K		H(m)	D(m)	Emax(lx)
Ra80			15°	
Fixture Power	13W	1	0.27	6192
Source Flux	1923lm	2	0.54	1548
Fixture Flux	661lm	3	0.82	688
Efficacy	49lm/W	4	1.09	387
TS815 Imax=3220cd/klm	Imax	6192cd	5	1.36	248

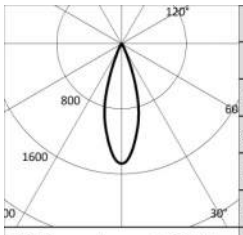


4000K		H(m)	D(m)	Emax(lx)
Ra80			15°	
Fixture Power	13W	1	0.27	6266
Source Flux	1946lm	2	0.54	1566
Fixture Flux	669lm	3	0.82	696
Efficacy	51lm/W	4	1.09	392
TS815 Imax=3220cd/klm	Imax	6266cd	5	1.36	251

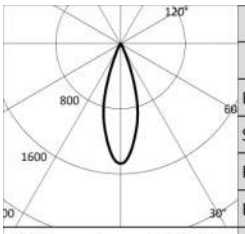
FLOOD



2700K		H(m)	D(m)	Emax(lx)
Ra80			32°	
Fixture Power	14W	1	0.58	2678
Source Flux	1823lm	2	1.15	670
Fixture Flux	831lm	3	1.73	298
Efficacy	61lm/W	4	2.30	167
TS816 Imax=1469cd/klm	Imax	2678cd	5	2.88	107



3000K		H(m)	D(m)	Emax(lx)
Ra80			32°	
Fixture Power	13W	1	0.58	2825
Source Flux	1923lm	2	1.15	706
Fixture Flux	876lm	3	1.73	314
Efficacy	65lm/W	4	2.30	177
TS816 Imax=1469cd/klm	Imax	2825cd	5	2.88	113

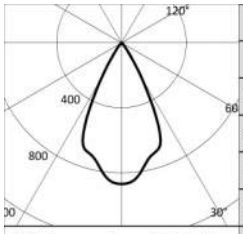


4000K		H(m)	D(m)	Emax(lx)
Ra80			32°	
Fixture Power	13W	1	0.58	2859
Source Flux	1946lm	2	1.15	715
Fixture Flux	887lm	3	1.73	318
Efficacy	68lm/W	4	2.30	179
TS816 Imax=1469cd/klm	Imax	2859cd	5	2.88	114

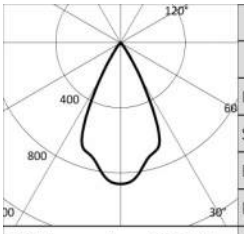
KEPLERO MINI ZOOM

PHOTOMETRY

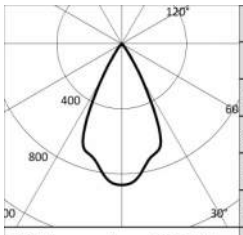
MEDIUM WIDE FLOOD



2700K		H(m)	D(m)	Emax(lx)
Ra80			53°	
Fixture Power	14W	1	0.99	1578
Source Flux	1823lm	2	1.98	394
Fixture Flux	1073lm	3	2.97	175
Efficacy	78lm/W	4	3.95	99
TS817 Imax=866cd/klm	Imax 1578cd	5	4.94	63

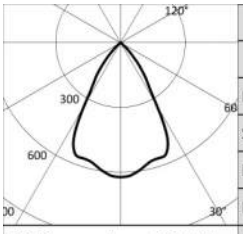


3000K		H(m)	D(m)	Emax(lx)
Ra80			53°	
Fixture Power	13W	1	0.99	1664
Source Flux	1923lm	2	1.98	416
Fixture Flux	1132lm	3	2.97	185
Efficacy	84lm/W	4	3.95	104
TS817 Imax=866cd/klm	Imax 1664cd	5	4.94	67

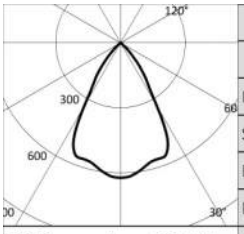


4000K		H(m)	D(m)	Emax(lx)
Ra80			53°	
Fixture Power	13W	1	0.99	1684
Source Flux	1946lm	2	1.98	421
Fixture Flux	1146lm	3	2.97	187
Efficacy	88lm/W	4	3.95	105
TS817 Imax=866cd/klm	Imax 1684cd	5	4.94	67

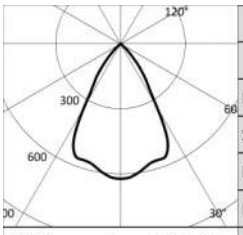
WIDE FLOOD



2700K		H(m)	D(m)	Emax(lx)
Ra80			61°	
Fixture Power	14W	1	1.18	1132
Source Flux	1823lm	2	2.37	283
Fixture Flux	1158lm	3	3.55	126
Efficacy	85lm/W	4	4.74	71
TS818 Imax=621cd/klm	Imax 1132cd	5	5.92	45



3000K		H(m)	D(m)	Emax(lx)
Ra80			61°	
Fixture Power	13W	1	1.18	1194
Source Flux	1923lm	2	2.37	299
Fixture Flux	1221lm	3	3.55	133
Efficacy	91lm/W	4	4.74	75
TS818 Imax=621cd/klm	Imax 1194cd	5	5.92	48

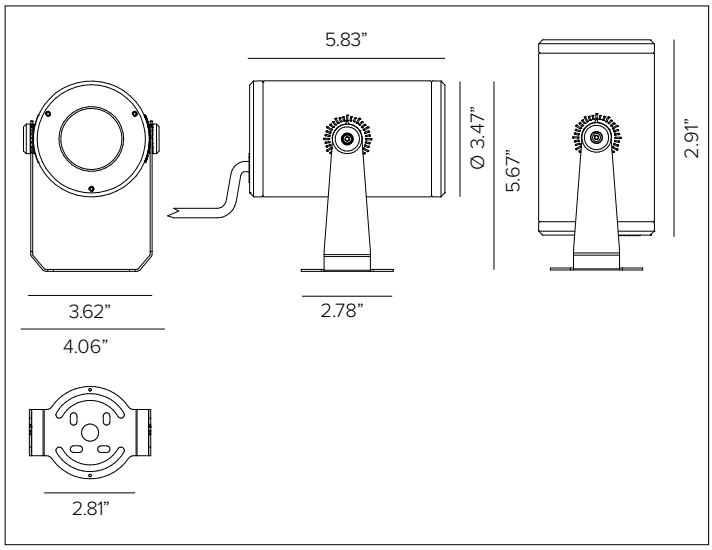


4000K		H(m)	D(m)	Emax(lx)
Ra80			61°	
Fixture Power	13W	1	1.18	1208
Source Flux	1946lm	2	2.37	302
Fixture Flux	1236lm	3	3.55	134
Efficacy	95lm/W	4	4.74	76
TS818 Imax=621cd/klm	Imax 1208cd	5	5.92	48

DART ROUND SMALL RGBW

Professional Small Scale Adjustable Dynamic Color Changing Projector Floodlight

DART ROUND SMALL RGBW Shown in Ferrite Dark Grey finish.



Marine | RoHS3 Compliant | IP66 | Class2

CONCEPT

Small footprint fully adjustable LED projector with high intensity RGBW LED’s for dynamic color changing illumination.

MECHANICAL CHARACTERISTICS

Dimensions	3.47”Dia x 4.06”W
Materials	Die-cast aluminum powder coated body and joints for maximum heat dissipation. Tempered extra clear glass lens. Marine Grade cataphoresis[A] available as optional.
Finish	Textured finish. Ferrite Dark Grey, Heritage Brown, Bronze, Black, White, Sandstone Grey
Power Connection	Direct burial 20-8, 4 conductor lead cable with quick disconnect in 10ft / 25ft / 50ft lengths, see required options.
Functionality	Adjustable up to ±60° on the horizontal plane with slotted mounting base and +90°/-45° on the vertical plane with aim locking set screw.
Mounting	Fixture can be installed directly to mounting surface or used with optional mounting installation accessories.
Weight	2.2lbs
EPA	0.17 *Includes Cd drag coefficient of 1.53. Does NOT include any optical accessories.*
Protection	IP66
Impact	IK10

CERTIFICATIONS

cULus Class 2 Wet Location Listed.
Tested in accordance with LM-79-08.
Compliant with California energy regulations.
IEC 62471.
RoHS3 EU 215/863

WARRANTY

5 year limited warranty

SUSTAINABILITY

Luminaire designed for disposal/recycling at end-of-life. Replaceable LED light source and control gear by a Targetti technician.

ELECTRICAL CHARACTERISTICS

Power Supply	Remote Class 2 power supply with DMX/RGBW interface required, see available options. Refer to Targetti Onsite Services for additional programing and installation support.
Wattage	11W / 4Ch
Voltage	850mA @ 3-4V DC per channel
Ambient Temp.	-25°C / +35°C (95°F)

SOURCE

High efficiency single RGBW LED quad chip.

TM30	***CCT (Nominal)***	***SDCM***
	RGBW 6500K	2

OPTIC

Equipped with precision methacrylate lens and spread filter.

Beam		***NSP 10°***	***SP 17°***	***FL 31°***	***MWFL 44°***
Delivered Lumens	***RED***	92Lm	85Lm	84Lm	82Lm
	GREEN	166Lm	154Lm	151Lm	147Lm
	BLUE	32Lm	30Lm	29Lm	29Lm
	6500K	250Lm	231Lm	226Lm	221Lm
	RGB	236Lm	219Lm	214Lm	209Lm
	RGBW	455Lm	421Lm	413Lm	403Lm
Efficacy	40Lm/W max. Refer to photometric graphs for specific values.				
Lifetime	L80/B10 60,000hrs at max TA +25°C				
Photobiological Classification	Low risk safety RG1				

DART ROUND SMALL RGBW

SPECIFICATION INFORMATION

DRS							/	/	/	/	/
1	2	3	4	5	6	7	8	9	10	11	12
						OPTIONAL	REQUIRED		OPTIONAL		

Ex: DRSRPFEL1SPRGBW / DX8PLEAD10 / PS041

1 - PRODUCT CODE	2 - DRIVER	3 - FINISH	4 - WATTAGE	5 - OPTIC	6 - KELVIN	7 - OPTIONAL
DRS — DART ROUND SMALL	**RP** – Remote Driver	**FE** — Ferrite Dark Grey **HB** — Heritage Brown **BZ** — Bronze **WT** — White **BT** — Black **SG** — Sandstone Grey **RAL** — Custom RAL	**L1** – 11W	**NS** – NSP 10° **SP** — SP 17° **FL** — FL 31° **MW** — MWFL 44°	**RGBW** – RGBW	**MG** [A] – Marine Grade

8 - LEAD CABLE	9 - POWER SUPPLY	10 - CONTROL	11 - OPTICAL ACCESSORIES	12 - INSTALLATION ACCESSORIES
Lead Cable *See section for details*	DMX Power Supply *See section for details*	DMX Controller *See section for details*	Filter Holder Ring *See section for details* Blade Light Linear Spread Lens *See section for details* Anti-glare Louver *See section for details* Asymmetric Snoot *See section for details*	Rotational Bracket *See section for details* Earth spike *See section for details* Back Plate *See section for details*

[A] Marine Grade is recommended for use in environments with occasional exposure to salt air, reclaimed water, fertilizers, chemical cleaners, or frequent pressure washing (steam) cleaning. Fixture housing complete with marine grade cataphoresis suitable for use in marine grade environments. Not to be in direct contact with salt or corrosive agents for extended periods of time.

DART ROUND SMALL RGBW

8 - LEAD CABLE (REQUIRED)

Direct burial 20-8 lead cable with IP68 quick disconnect.			
Length	10ft	25ft	50ft
Part No.	**DX8PLEAD10**	**DX8PLEAD25**	**DX8PLEAD50**

9 – POWER SUPPLY (REQUIRED)

STANDALONE							
Part No.	*Wattage*	*Control*	*Dim Range*	*In / Out Voltage*	*Certification*	*Dimensions (Standalone)*	*Description*
PS041 *1 fixture max per driver*	50W 850mA 4 Chan	DMX / RDM *1 fixture max*	0%	Universal 120-277V AC	UR Class 2	6.00" x 3.00" x 1.20"	EldoLED POWERdrive 561/A1 Class 2 Power Supply, side feed only. **UL listed enclosure provided by others.**

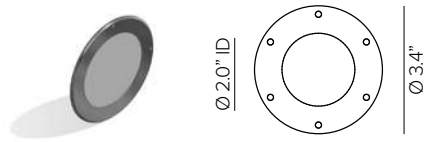
10 – CONTROL (OPTIONAL)

Part No.		*Channels*	*Scenes*	*Zones*	*Rating*	*Voltage*	*Certification*	*Dimensions*	*Description*
TGDMXSLESAU9		256	20	1	Indoor	5.5V DC	ETL, UL	5.3"W x 5.5"H x 1.9D	Nicolaudie Slesa smart DMX 1/2 universe programmable controller with easy to use software interface.
TGDMXSLESAU11		1024	99	5	Indoor	5VDC 120V AC *Plug in power supply included*	ETL	6.3" x 3.6" x 1.8"	Nicolaudie Slesa smart DMX interface, 2 DMX 512 universes, intuitive backlit keyboard programmable controller with easy to use software interface.
TGDMXSTICKDE3B		1024	500	10	Indoor	6-7V DC 120V AC *Plug in power supply included*	ETL	5.8" x 4.2" x 0.5"	Nicolaudie intelligent control keypad with glass touch sensitive graphic display, stand-alone DMX 512, 2 universe programmable controller with easy to use software interface. Black finish.
TGDMXSTICKDE3W		1024	500	10	Indoor	6-7V DC 120V AC *Plug in power supply included*	ETL	5.8" x 4.2" x 0.5"	Nicolaudie intelligent control keypad with glass touch sensitive graphic display, stand-alone DMX 512, 2 universe programmable controller with easy to use software interface. White finish.

DART ROUND SMALL RGBW

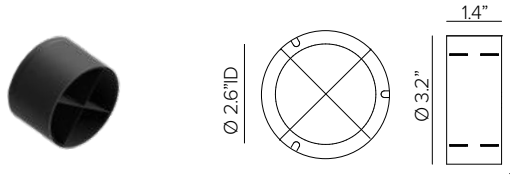
EXTERNAL OPTICAL ACCESSORIES (OPTIONAL)

MAXIMUM OF TWO ACCESSORIES PER FIXTURE.



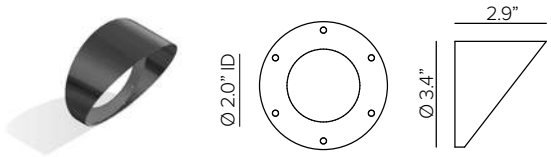
Blade Light Linear Spread Lens. PMMA holographic filter.

Part No. **1E4002 (*)**



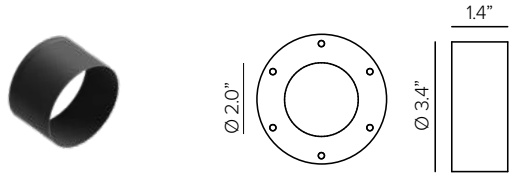
Anti glare louver with internal baffles for glare control. Powder coat stainless steel. Cutoff 103°. **Not compatible with 1E4003, 1E4004 or 1E4057.**

Part No. **1E4005 (*)**



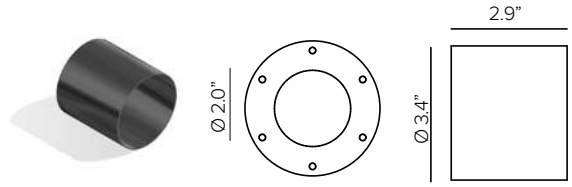
Asymmetric snoot. Powder coated stainless steel. Cutoff 53°. **Not compatible with 1E4004, 1E4005 or 1E4057.**

Part No. **1E4003 (*)**



Symmetric snoot. Powder coated stainless steel. Cutoff 109°. **Not compatible with 1E4003, 1E4005 or 1E4057.**

Part No. **1E4004 (*)**



Symmetric super snoot. Powder coated stainless steel. Cutoff 53°. **Not compatible with 1E4003, 1E4004 or 1E4005.**

Part No. **1E4057 (*)**

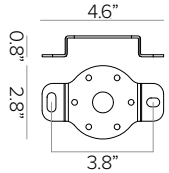
Ferrite Dark Grey *(Default)* · Heritage Brown (**HB**)* · Bronze (**BZ**)* · White (**WT**)* · Black (**BT**)* · Sandstone Grey (**SG**)*

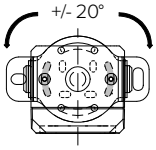
Add suffix to end of number to identify finish (EX. 1E3015HB)

DART ROUND SMALL RGBW

INSTALLATION ACCESSORIES (OPTIONAL)

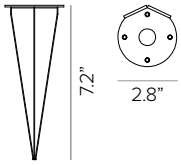
MAXIMUM OF ONE ACCESSORY PER FIXTURE





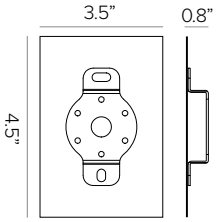
Rotational bracket for surface installation. Powder coated stainless steel.

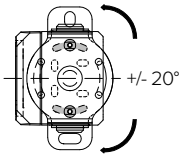
Part No. **1E3015 (*)**



Earth spike. Powder coated stainless steel.

Part No. **1E3016 (*)**





Back plate with rotational bracket for wall mount installation. Powder coated stainless steel with Neoprene black foam. Included with 1E3015 and factory attached Stainless Steel black oxide bolts and locking nuts.

Part No. **1US3015 (*)**

Ferrite Dark Grey *(Default)* | Heritage Brown (**HB**)* | Bronze (**BZ**)* | White (**WT**)* | Black (**BT**)* | Sandstone Grey (**SG**)*

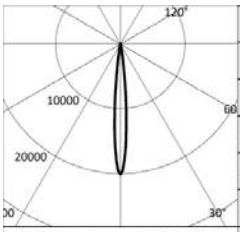
Add suffix to end of number to identify finish (EX. 1E3015HB)

DART ROUND SMALL RGBW

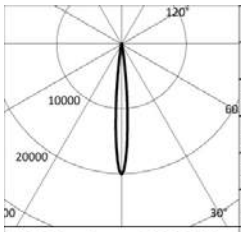
PHOTOMETRY

IES FILES WATTAGE AND EFFICIENCY CALCULATIONS BASED WITH SUPPLIED DRIVER

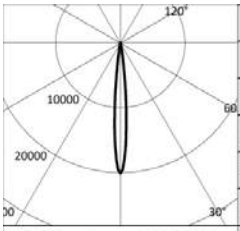
NARROW SPOT



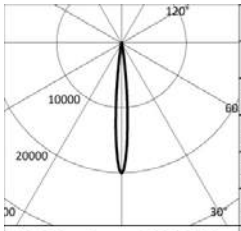
RED		H(m)	D(m)	Emax(lx)
-			10°	
Fixture Power	2W	1	0.18	2128
Source Flux	106lm	2	0.35	532
Fixture Flux	92lm	3	0.53	236
Efficacy	40lm/W	4	0.71	133
TS1664 Imax=20066cd/klm	Imax 2128cd	5	0.88	85



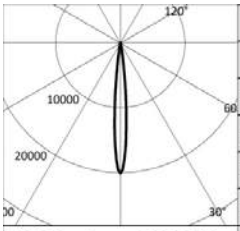
GREEN		H(m)	D(m)	Emax(lx)
-			10°	
Fixture Power	3W	1	0.18	3834
Source Flux	191lm	2	0.35	958
Fixture Flux	166lm	3	0.53	426
Efficacy	50lm/W	4	0.71	240
TS1664 Imax=20066cd/klm	Imax 3834cd	5	0.88	153



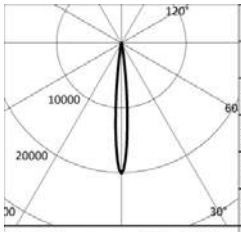
BLUE		H(m)	D(m)	Emax(lx)
-			10°	
Fixture Power	3W	1	0.18	747
Source Flux	37lm	2	0.35	187
Fixture Flux	32lm	3	0.53	83
Efficacy	11lm/W	4	0.71	47
TS1664 Imax=20066cd/klm	Imax 747cd	5	0.88	30



6500K		H(m)	D(m)	Emax(lx)
-			10°	
Fixture Power	3W	1	0.18	5754
Source Flux	287lm	2	0.35	1438
Fixture Flux	250lm	3	0.53	639
Efficacy	81lm/W	4	0.71	360
TS1664 Imax=20066cd/klm	Imax 5754cd	5	0.88	230



RGB		H(m)	D(m)	Emax(lx)
-			10°	
Fixture Power	7W	1	0.18	5445
Source Flux	271lm	2	0.35	1361
Fixture Flux	236lm	3	0.53	605
Efficacy	36lm/W	4	0.71	340
TS1664 Imax=20066cd/klm	Imax 5445cd	5	0.88	218



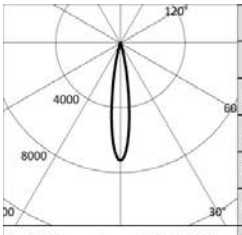
RGBW		H(m)	D(m)	Emax(lx)
-			10°	
Fixture Power	11W	1	0.18	10482
Source Flux	522lm	2	0.35	2621
Fixture Flux	455lm	3	0.53	1165
Efficacy	40lm/W	4	0.71	655
TS1664 Imax=20066cd/klm	Imax 10482cd	5	0.88	419

DART ROUND SMALL RGBW

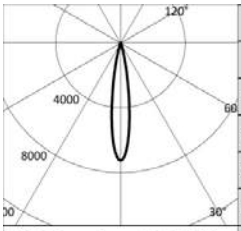
PHOTOMETRY

IES FILES WATTAGE AND EFFICIENCY CALCULATIONS BASED WITH SUPPLIED DRIVER

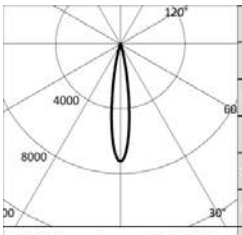
SPOT



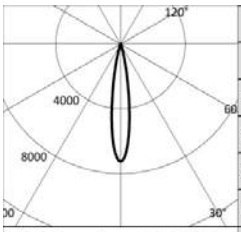
RED		H(m)	D(m)	Emax(lx)
-			17°	
Fixture Power	2W	1	0.29	766
Source Flux	106lm	2	0.59	192
Fixture Flux	85lm	3	0.88	85
Efficacy	37lm/W	4	1.18	48
TS1665 Imax=7227cd/klm	Imax 766cd	5	1.47	31



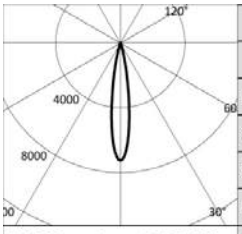
GREEN		H(m)	D(m)	Emax(lx)
-			17°	
Fixture Power	3W	1	0.29	1381
Source Flux	191lm	2	0.59	345
Fixture Flux	154lm	3	0.88	153
Efficacy	47lm/W	4	1.18	86
TS1665 Imax=7227cd/klm	Imax 1381cd	5	1.47	55



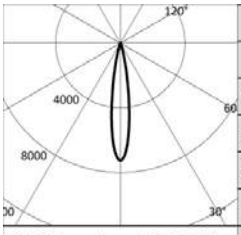
BLUE		H(m)	D(m)	Emax(lx)
-			17°	
Fixture Power	3W	1	0.29	269
Source Flux	37lm	2	0.59	67
Fixture Flux	30lm	3	0.88	30
Efficacy	10lm/W	4	1.18	17
TS1665 Imax=7227cd/klm	Imax 269cd	5	1.47	11



6500K		H(m)	D(m)	Emax(lx)
-			17°	
Fixture Power	3W	1	0.29	2072
Source Flux	287lm	2	0.59	518
Fixture Flux	231lm	3	0.88	230
Efficacy	74lm/W	4	1.18	130
TS1665 Imax=7227cd/klm	Imax 2072cd	5	1.47	83



RGB		H(m)	D(m)	Emax(lx)
-			17°	
Fixture Power	7W	1	0.29	1961
Source Flux	271lm	2	0.59	490
Fixture Flux	219lm	3	0.88	218
Efficacy	33lm/W	4	1.18	123
TS1665 Imax=7227cd/klm	Imax 1961cd	5	1.47	78



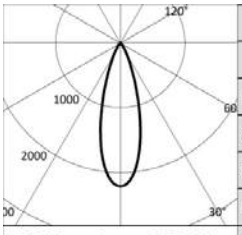
RGBW		H(m)	D(m)	Emax(lx)
-			17°	
Fixture Power	11W	1	0.29	3775
Source Flux	522lm	2	0.59	944
Fixture Flux	421lm	3	0.88	419
Efficacy	37lm/W	4	1.18	236
TS1665 Imax=7227cd/klm	Imax 3775cd	5	1.47	151

DART ROUND SMALL RGBW

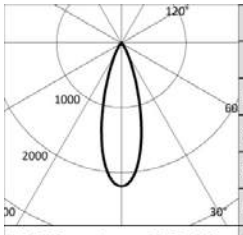
PHOTOMETRY

IES FILES WATTAGE AND EFFICIENCY CALCULATIONS BASED WITH SUPPLIED DRIVER

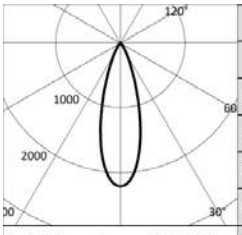
FLOOD



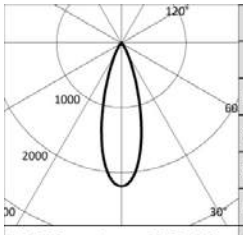
RED		H(m)	D(m)	Emax(lx)
-			31°	
Fixture Power	2W	1	0.55	234
Source Flux	106lm	2	1.11	58
Fixture Flux	84lm	3	1.66	26
Efficacy	36lm/W	4	2.21	15
TS1666 Imax=2205cd/klm	Imax 234cd	5	2.77	9



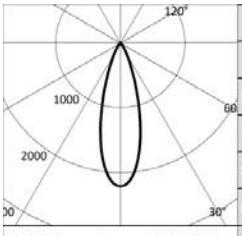
GREEN		H(m)	D(m)	Emax(lx)
-			31°	
Fixture Power	3W	1	0.55	421
Source Flux	191lm	2	1.11	105
Fixture Flux	151lm	3	1.66	47
Efficacy	46lm/W	4	2.21	26
TS1666 Imax=2205cd/klm	Imax 421cd	5	2.77	17



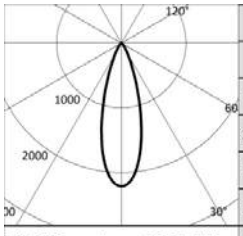
BLUE		H(m)	D(m)	Emax(lx)
-			31°	
Fixture Power	3W	1	0.55	82
Source Flux	37lm	2	1.11	21
Fixture Flux	29lm	3	1.66	9
Efficacy	10lm/W	4	2.21	5
TS1666 Imax=2205cd/klm	Imax 82cd	5	2.77	3



6500K		H(m)	D(m)	Emax(lx)
-			31°	
Fixture Power	3W	1	0.55	632
Source Flux	287lm	2	1.11	158
Fixture Flux	226lm	3	1.66	70
Efficacy	73lm/W	4	2.21	40
TS1666 Imax=2205cd/klm	Imax 632cd	5	2.77	25



RGB		H(m)	D(m)	Emax(lx)
-			31°	
Fixture Power	7W	1	0.55	598
Source Flux	271lm	2	1.11	150
Fixture Flux	214lm	3	1.66	66
Efficacy	32lm/W	4	2.21	37
TS1666 Imax=2205cd/klm	Imax 598cd	5	2.77	24



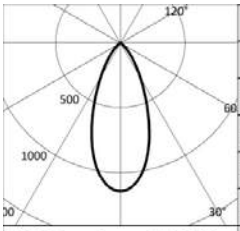
RGBW		H(m)	D(m)	Emax(lx)
-			31°	
Fixture Power	11W	1	0.55	1152
Source Flux	522lm	2	1.11	288
Fixture Flux	413lm	3	1.66	128
Efficacy	36lm/W	4	2.21	72
TS1666 Imax=2205cd/klm	Imax 1152cd	5	2.77	46

DART ROUND SMALL RGBW

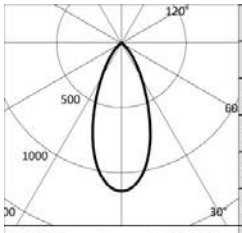
PHOTOMETRY

IES FILES WATTAGE AND EFFICIENCY CALCULATIONS BASED WITH SUPPLIED DRIVER

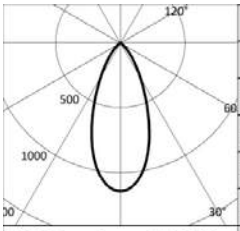
MEDIUM WIDE FLOOD



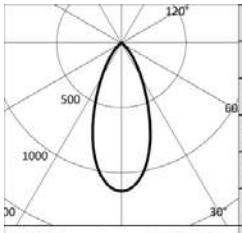
RED		H(m)	D(m)	Emax(lx)
-			44°	
Fixture Power	2W	1	0.80	121
Source Flux	106lm	2	1.60	30
Fixture Flux	82lm	3	2.40	13
Efficacy	36lm/W	4	3.19	8
TS1667 Imax=1140cd/klm	Imax 121cd	5	3.99	5



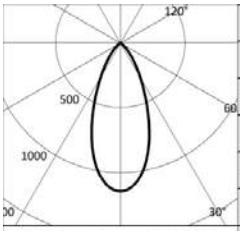
GREEN		H(m)	D(m)	Emax(lx)
-			44°	
Fixture Power	3W	1	0.80	218
Source Flux	191lm	2	1.60	54
Fixture Flux	147lm	3	2.40	24
Efficacy	45lm/W	4	3.19	14
TS1667 Imax=1140cd/klm	Imax 218cd	5	3.99	9



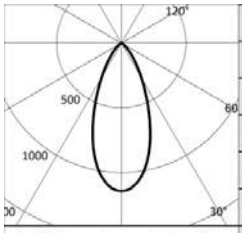
BLUE		H(m)	D(m)	Emax(lx)
-			44°	
Fixture Power	3W	1	0.80	42
Source Flux	37lm	2	1.60	11
Fixture Flux	29lm	3	2.40	5
Efficacy	10lm/W	4	3.19	3
TS1667 Imax=1140cd/klm	Imax 42cd	5	3.99	2



6500K		H(m)	D(m)	Emax(lx)
-			44°	
Fixture Power	3W	1	0.80	327
Source Flux	287lm	2	1.60	82
Fixture Flux	221lm	3	2.40	36
Efficacy	71lm/W	4	3.19	20
TS1667 Imax=1140cd/klm	Imax 327cd	5	3.99	13



RGB		H(m)	D(m)	Emax(lx)
-			44°	
Fixture Power	7W	1	0.80	309
Source Flux	271lm	2	1.60	77
Fixture Flux	209lm	3	2.40	34
Efficacy	32lm/W	4	3.19	19
TS1667 Imax=1140cd/klm	Imax 309cd	5	3.99	12

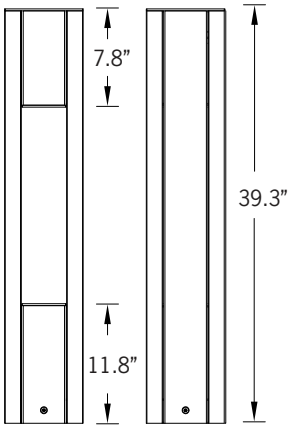


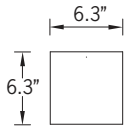
RGBW		H(m)	D(m)	Emax(lx)
-			44°	
Fixture Power	11W	1	0.80	596
Source Flux	522lm	2	1.60	149
Fixture Flux	403lm	3	2.40	66
Efficacy	35lm/W	4	3.19	37
TS1667 Imax=1140cd/klm	Imax 596cd	5	3.99	24

UVA-10151

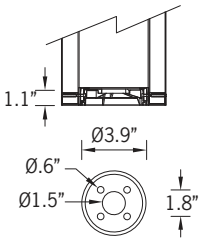
Vancouver 39 Bollard

15w COB 418 Lumens
IP65 • Suitable For Wet Locations
IK08 • Impact Resistant (Vandal Resistant)
Weight 22.5 lbs





Top View



Mounting Detail

Construction

Aluminum
Less than 0.1% copper content – Marine Grade 6060 extruded & LM6 Aluminum High Pressure die casting provides excellent mechanical strength , clean detailed product lines and excellent heat dissipation.

Pre paint
8 step degrease and phosphate process that includes deoxidizing and etching as well as a zinc and nickel phosphate process before product painting.

Memory Retentive -Silicon Gasket
Provided with special injection molded "fit for purpose" long life high temperature memory retentive silicon gaskets. Maintains the gaskets exact profile and seal over years of use and compression.

Thermal management
LM6 Aluminum is used for its excellent mechanical strength and thermal dissipation properties in low and high ambient temperatures. The superior thermal heat sink design by Ligman used in conjunction with the driver, controls thermals below critical temperature range to ensure maximum luminous flux output, as well as providing long LED service life and ensuring less than 10% lumen depreciation at 50,000 hours.

Surge Suppression
Standard 10kv surge suppressor provided with all fixtures.

BUG Rating
Contact Factory

Finishing
All Ligman products go through an extensive finishing process that includes fettling to improve paint adherence.

Paint
UV Stabilized 4.9Mil thick powder coat paint and baked at 200˚ C. This process ensures that Ligman products can withstand harsh environments. Rated for use in natatoriums.

Inspired by Nature Finishes
The Inspired by nature Finishing is a unique system of decorative powder coating. Our metal decoration process can easily transform the appearance of metal or aluminum product into a wood grain finish.

This patented technology enables the simulation of wood grain, and even marble or granite finish through the use of decorative powder coating.

The wood grain finish is so realistic that it's almost undistinguishable from real wood, even from a close visual inspection. The system of coating permeates the entire thickness of the coat and as a result, the coating cannot be removed by normal rubbing, chipping, or scratching.

The Coating Process
After pre-treatment the prepared parts are powder coated with a specially formulated polyurethane powder. This powder provides protection against wear, abrasion, impact and corrosion and acts as the relief base color for the finalized metal decoration.

The component is then wrapped with a sheet of non-porous film with the selected decoration pattern printed on it using special high temperature inks.

This printed film transfer is vacuum-sealed to the surface for a complete thermo print and then transferred into a customized oven. The oven transforms the ink into different forms within the paint layer before it becomes solid. Finally, the film is removed, and a vivid timber look on aluminum remains.

Wood grain coating can create beautiful wood-looking products of any sort. There are over 300 combinations of designs currently in use. Wood grains can be made with different colors, designs, etc.

Our powder coatings are certified for indoor and outdoor applications and are backed by a comprehensive warranty. These coatings rise to the highest conceivable standard of performance excellence and design innovation.

Added Benefits
- Resistance to salt-acid room, accelerated aging
- Boiling water, lime and condensed water resistant
- Anti-Graffiti, Anti-Slip, Anti-Microbial, Anti-Scratch
- Super durable (UV resistant)
- TGIC free (non-toxic)

Hardware
Provided Hardware is Marine grade 316 Stainless steel.

Anti Seize Screw Holes
Tapped holes are infused with a special anti seize compound designed to prevent seizure of threaded connections, due to electrolysis from heat, corrosive atmospheres and moisture.

Crystal Clear Low Iron Glass Lens
Provided with tempered, impact resistant crystal clear low iron glass ensuring no green glass tinge.

Optics & LED
Precise optic design provides exceptional light control and precise distribution of light.
LED CRI > 80

Lumen - Maintenance Life
L80 /B10 at 50,000 hours (This means that at least 90% of the LED still achieve 80% of their original flux)

Contemporary urban lighting furniture.
Open-sided, three lattice pattern options or your bespoke design.

A stylish Dark Sky Compliant square high performance bollard with downward light distribution using LED lamps. This light column offers optimal visual comfort through glare control by utilizing a controlled optics designed by Ligman. These bollards have a square design providing a unique wide light distribution, offering an architecturally appealing clover leaf pattern on the paving. The internal sides of the supporting pillars are accented by light from the LED.

Color temperature 2700K, 3000K, 3500K and 4000K. The minimalistic shape provides distinctive lighting effects by night and decorative urban effect during the day. Suitable for pedestrian areas, precincts, building surrounds, shopping centers, squares and parks. The Vancouver Bollard comes standard with a unique waterproof internal driver housing compartment that is situated at the top of the pole to stop water and dust from entering the electrical components. This fixture is supplied completely wired with powercord and waterproof gland from the driver enclosure to the base of the column to ensure quick trouble-free installation.

The Vancouver has a specially designed anchor bolt mounting base that is partially buried below ground level to provide a flush fixture finish with the surface, but maintains the rigidity that is required when installing bollards.

Custom bollard heights are available, please specify. Provided with anchor bolts Reduced custom wattages can be provided to suit customer requirements. (Specify total watt requirement per fixture)

• NOTE: For the round version of the Vancouver, please see the Benton Light Column and Bollard

To meet International Dark Sky criteria, 3000k or warmer LEDs must be selected.

Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements in LED technology data and components may change without notice.

UVA-10151

Vancouver 39 Bollard

LIGMAN LIGHTING USA

PROJECT		DATE	

QUANTITY		TYPE		NOTE	

ORDERING EXAMPLE || UVA - 10151 - 15w - W30 - 02 - 120/277v - Options

UVA-10151

LAMP

15w COB
418 Lumens

LED COLOR

W27 - 2700K
W30 - 3000K
W35 - 3500K
W40 - 4000K

FINISH COLOR

01 - BLACK RAL 9011
02 - DARK GREY RAL 7043
03 - WHITE RAL 9003
04 - METALLIC SILVER RAL 9006
05 - MATTE SILVER RAL 9006
06 - LIGMAN BRONZE
07 - CUSTOM RAL

INSPIRED BY NATURE FINISHES

SW01 - OAK FINISH
SW02 - WALNUT FINISH
SW03- PINE FINISH
DF - DOUGLAS FIR FINISH
CW - CHERRY WOOD FINISH
NW - NATIONAL WALNUT FINISH
SU01 - CONCRETE FINISH
SU02 - SOFTSCAPE FINISH
SU03 - STONE FINISH
SU04 - CORTEN FINISH

THERE IS AN ADDITIONAL COST FOR THESE FINISHES

VOLTAGE

120/277v
Other - Specify

ADDITIONAL OPTIONS

NAT - Natatorium Rated
DIM - 0-10v Dimming
HGT - Custom Bollard Height
GFCI - GFCI Box

More Custom Finishes Available Upon Request

Consult factory for pricing and lead times

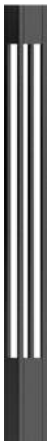
Oak
Cherry
Beech
Carbon
Walnut
Chestnut
Bamboo
Galvanized
Pine
Mahogany
Birch
Steel

Example: Two-Tone Inspired by Nature Finish

Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements in LED technology data and components may change without notice.

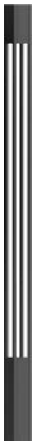
Intertek

Vancouver Product Family



Vancouver 1

- UVA-20001-40w-2969lm [9.4"x9.4"-14.7']



Vancouver 2

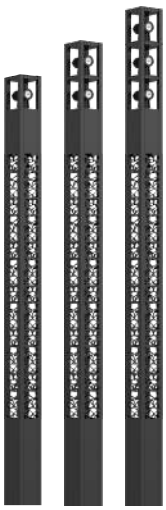
- UVA-20011-20w-1414lm [6.3"x6.3"-9.8']

Vancouver 3

- UVA-10001-21w-1270lm [9.4"x9.4"-39.3"]

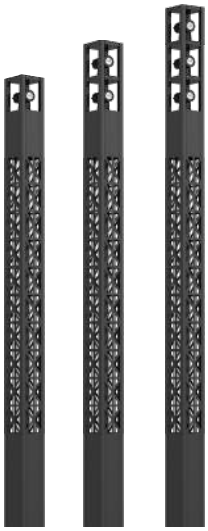
Vancouver 4

- UVA-10011-15w-837lm [6.3"x6.3"-39.3"]



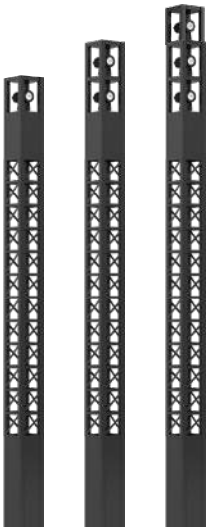
Vancouver 5

- UVA-20021-39/21w-1336/1673lm [9.4"x9.4"-13.3']
- UVA-20022-39/2x21w-1336/2x1673lm [9.4"x9.4"-14.5']
- UVA-20023-39/3x21w-1336/3x1673lm [9.4"x9.4"-15.7']



Vancouver 6

- UVA-20031-39/21w-1167/1673lm [9.4"x9.4"-13.3']
- UVA-20032-39/2x21w-1167/2x1673lm [9.4"x9.4"-14.5']
- UVA-20033-39/3x21w-1167/3x1673lm [9.4"x9.4"-15.7']



Vancouver 7

- UVA-20041-39/21w-1670/1673lm [9.4"x9.4"-13.3']
- UVA-20042-39/2x21w-1670/2x1673lm [9.4"x9.4"-14.5']
- UVA-20043-39/3x21w-1670/3x1673lm [9.4"x9.4"-15.7']

Vancouver 8

- UVA-20051-40w-1336lm [9.4"x9.4"-12.1']

Vancouver 9

- UVA-20061-40w-1167lm [9.4"x9.4"-12.1']

Vancouver 10

- UVA-20071-40w-1670lm [9.4"x9.4"-12.1']

Vancouver 11

- UVA-10021-21w-570lm [9.4"x9.4"-39.3']

Vancouver 12

- UVA-10031-21w-490lm [9.4"x9.4"-39.3']

Vancouver 13

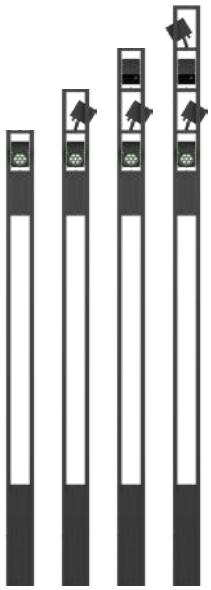
- UVA-10041-21w-704lm [9.4"x9.4"-39.3']

Vancouver 14

- UVA-70001-8w-331lm [6.3"x6.3"-15.7"]

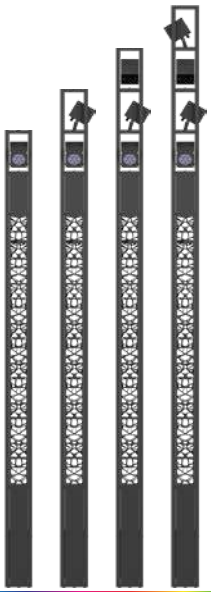
Vancouver 15

- UVA-70011-21w-815lm [9.4"x9.4"-15.7"]



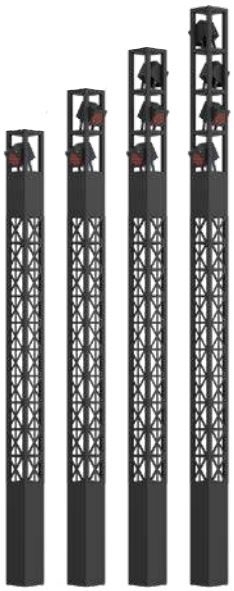
Vancouver 16

- UVA-20111-33w-1429lm [9.4"x9.4"-13.3']
- UVA-20112-66w-4287lm [9.4"x9.4"-14.5']
- UVA-20113-99w-5716lm [9.4"x9.4"-15.7']
- UVA-20114-132w-7145lm [9.4"x9.4"-17']



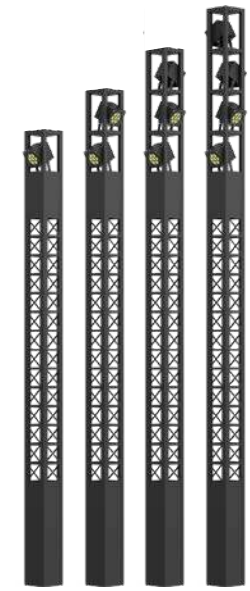
Vancouver 17

- UVA-20121-33w-2858 lm [9.4"x9.4"-13.3']
- UVA-20122-66w-4287lm [9.4"x9.4"-14.5']
- UVA-20123-99w-5716lm [9.4"x9.4"-15.7']
- UVA-20124-132w-7145lm [9.4"x9.4"-17']



Vancouver 18

- UVA-20131-33w-2858lm [9.4"x9.4"-13.3']
- UVA-201312-66w-4287lm [9.4"x9.4"-14.5']
- UVA-20133-99w-5716lm [9.4"x9.4"-15.7']
- UVA-20134-132w-7145lm [9.4"x9.4"-17']



Vancouver 19

- UVA-20141-33w-2858lm [9.4"x9.4"-13.3']
- UVA-20142-66w-4287lm [9.4"x9.4"-14.5']
- UVA-20143-99w-5716lm [9.4"x9.4"-15.7']
- UVA-20144-132w-7145lm [9.4"x9.4"-17']

Vancouver 20

- UVA-20151-33w-1429lm [9.4"x9.4"-12.1']

Vancouver 21

- UVA-20161-33w-1429lm [9.4"x9.4"-12.1']

Vancouver 22

- UVA-20171-33w-1429lm [9.4"x9.4"-12.1']

Vancouver 23

- UVA-20181-33w-1429lm [9.4"x9.4"-12.1']

Vancouver 24

- UVA-30001-8w-331lm [6.3"x6.3"-15.7"]

Vancouver 25

- UVA-30011-21w-570lm [6.3"x6.3"-23.6"]

Vancouver 26

- UVA-30012-21w-490lm [6.3"x6.3"-23.6"]

Vancouver 27

- UVA-30013-21w-740lm [6.3"x6.3"-23.6"]

Vancouver 28

- UVA-30021-39w-1336lm [9.4"x9.4"-39.3"]
- UVA-30031-33w RGBW-429lm [9.4"x9.4"-39.3"]

Vancouver 29

- UVA-30022-39w-1167lm [9.4"x9.4"-39.3"]
- UVA-30032-33w RGBW-1158lm [9.4"x9.4"-39.3"]

Vancouver 30

- UVA-30023-39w-1670lm [9.4"x9.4"-39.3"]
- UVA-30033-33w RGBW-439lm [9.4"x9.4"-39.3"]

Vancouver 31

• UVA-10101-7w-200lm [4.7" x 4.7" - 23.6"]

Vancouver 33

• UVA-10051-15w-1083lm [6.3" x 6.3" - 39.3"]

Vancouver 34

• UVA-10061-21w-1571lm [9.4" x 9.4" - 39.3"]

Vancouver 35

• UVA-10071-21w-1571lm [9.4" x 9.4" - 39.3"]

Vancouver 36

• UVA-10072-21w-1571lm [9.4" x 9.4" - 39.3"]

Vancouver 37

• UVA-10073-21w-1571lm [9.4" x 9.4" - 39.3"]

Vancouver 38

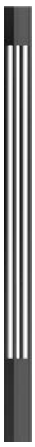
• UVA-10141-8w-95lm [4.7" x 4.7" - 23.6"]

Vancouver 39

• UVA-10151-15w-418lm [6.3" x 6.3" - 39.3"]

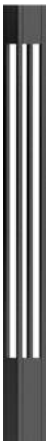
Vancouver 40

• UVA-10161-21w-635lm [9.4" x 9.4" - 39.3"]



Vancouver 41

• UVA-20191-20w-1326lm [6.3" x 6.3" - 9.8']



Vancouver 42

• UVA-20201-40w-2969 lm [9.4" x 9.4" - 14.7']

Vancouver 43

• UVA-20211-39/21w-2781/1688lm [9.4"x9.4"-13.3']

Vancouver 44

• UVA-20212-39/2x21w-2781/2x1688lm [9.4"x9.4"-14.5']

Vancouver 45

• UVA-20213-39/3x21w-2781/3x1688lm [9.4"x9.4"-15.7']

Vancouver 46

• UVA-20221-39/21w-4469/1688lm [9.4"x9.4"-13.3']

Vancouver 47

• UVA-20221-39/2x21w-4469/2x1688lm [9.4"x9.4"-14.5']

Vancouver 48

• UVA-20223-39/3x21w-4469/3x1688lm [9.4"x9.4"-15.7']

Vancouver 49

• UVA-20231-39/21w-2781/1688lm [9.4"x9.4"-13.3']

Vancouver 50

• UVA-20232-39/2x21w-2781/2x1688lm [9.4"x9.4"-14.5']

Vancouver 51

• UVA-20233-39/2x21w-2781/2x1688lm [9.4"x9.4"-15.7']

Vancouver 52

• UVA-20241-40w-2781lm [9.4"x9.4"-12']

Vancouver 53

• UVA-20242-40w-2781lm [9.4"x9.4"-12']

Vancouver 54

• UVA-20243-40w-2781lm [9.4"x9.4"-12']

Vancouver 55

• UVA-20251-21w-710lm [6.3"x6.3"-9.8']

Vancouver 56

• UVA-20261-40w-1485lm [9.4"x9.4"-14.7']

Vancouver 60

• UVA-20281-76w-4140lm [9.4"x9.4"-12']

Vancouver 61

• UVA-20282-76w-4140lm [9.4"x9.4"-12']

Vancouver 62

• UVA-20283-76w-4140lm [9.4"x9.4"-12']

Vancouver 63

• UVA-70021-13w-437lm [6.3"x6.3"-15.7']

Vancouver 64

• UVA-70031-20w-1362lm [9.4"x9.4"-15.7']

Vancouver 65

• UVA-70041-8w-165lm [6.3"x6.3"-15.7"]

Vancouver 66

• UVA-70051-21w-410lm [9.4"x9.4"-15.7"]

Vancouver 67

• UVA-30041-20w-1326lm [6.3."x6.3"-23.6"]

Vancouver 68

• UVA-30042-20w-1326lm [6.3."x6.3"-23.6"]

Vancouver 69

• UVA-30043-20w-1326lm [6.3."x6.3"-23.6"]

Vancouver 70

• UVA-30051-40w-2781lm [9.4"x9.4"-39.3"]

Vancouver 71

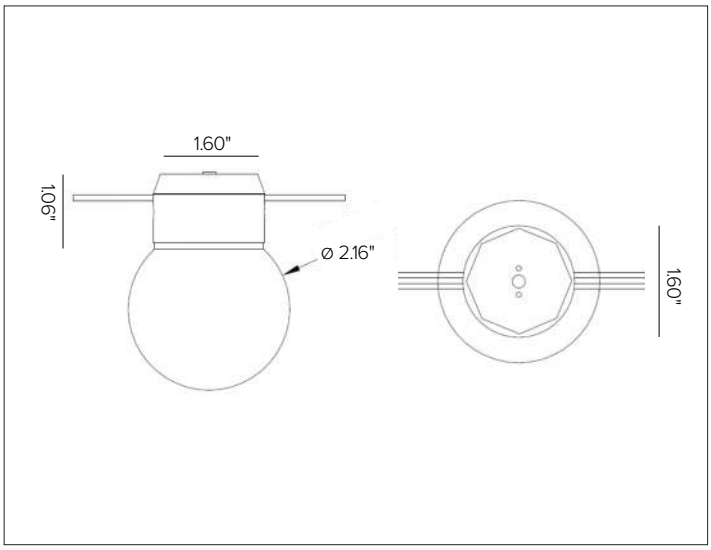
• UVA-30052-40w-2781lm [9.4"x9.4"-39.3"]

Vancouver 72

• UVA-30053-40w-2781lm [9.4"x9.4"-39.3"]

INTELLISTRAND RGB

Dynamic Color Changing Low Voltage Strand



IP65

CONCEPT

Low voltage dynamic color changing cable light strand, perfect for festoon mounting, taught or swayed.

MECHANICAL CHARACTERISTICS

Power Connection	16-3 cable with factory attached sockets.	
Spacing	12” O.C. / 24” O.C.	
Installation	For festoon mounting, fixture can be mounted to aircraft cable or secured with cable ties. Recommended for use with cable wrap option to encase both aircraft cable and Intellistrand cable for a clean, one wire look. For surface mounting, the flat back of the fixtures can secured with surface mount clip.	
Protection	IP65	
Weight	0.25Lbs per socket	
Max. Length	12” O.C.: 75’ max per run	24” O.C.: 150’ max per run

CERTIFICATIONS

cETLus Class 2 Wet Listed 4007019
Energy efficient for California installations
Tested in accordance RoHS3 EU 215/863

WARRANTY

5 year limited warranty

ELECTRICAL CHARACTERISTICS

Power Supply	Remote Class 2 120V-277V AC power supply required, see available options. Operates with DMX-Over-Power, Non-Dimming Power Supply and DMX 512 control wired together in 3 conductor configuration. 0% dim range. 24 bit individually addressable spheres for dramatic full color lighting effects. Refer to Targetti Onsite Services for additional programing and installation support.
Wattage	1.1W max./Sphere
Voltage	24V DC

SOURCE

6 high efficiency tri-chip LED diodes.

TM30	***CCT (Nominal)***	
	RGB	

OPTIC

Polycarbonate spherical opal lens.

Beam		***Opal 360° x 200°***
Delivered Lumens	***2300k***	45Lm/Sphere
Efficacy	40.91Lm/W	
Lifetime	L90 40,000hrs at max TA +25ºC	

INTELLISTRAND RGB

SPECIFICATION INFORMATION

IN	CL					/	/	/	/	/	/
1	2	3	4	5	6	7	8	9	10	11	12
						REQUIRED		OPTIONAL	REQUIRED	OPTIONAL	

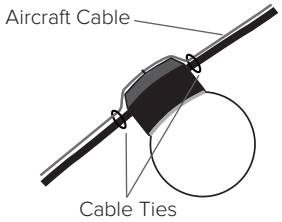
Ex: INCL1FC1224 / INTEL06 / INTEL08 / DEL10013524

1 - PRODUCT CODE	2- TYPE	3- WATTAGE	4 - COLOR TEMP	5 - SPACING	6 - VOLTAGE
IN — Intellistrand	**CL** – Cable Light	**1** – 1W	**FC** – RGB	**12** – 12" O.C. **24** – 24" O.C.	**24** – 24V DC

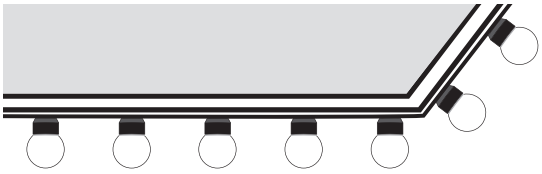
7 - CONNECTION	8 - END CAP	9 - MOUNTING	10 - POWER SUPPLY	11 - CONTROL	12 - DECORATIVE
3ft 4 Pole Connector *See section for details* 8ft 4 Pole Connector *See section for details* 16ft 4 Pole Connector *See section for details* 20ft 4 Pole Connector *See section for details* T-Split Cable Connector *See section for details* DMX T-Split Cable Connector *See section for details* 10ft 2 Pole Connector *See section for details* 20ft 2 Pole Connector *See section for details*	End Cap *See section for details*	Aircraft Cable *See section for details* Spiral Cable Wrap *See section for details*	Power Supply *See section for details*	DMX Controller *See section for details*	Decorative Shade *See section for details*

NOTE: Fixture is project specific and manufactured to order, longer lead times may be expected based on a project volumes. Consult factory for more information.

INSTALLATION EXAMPLES

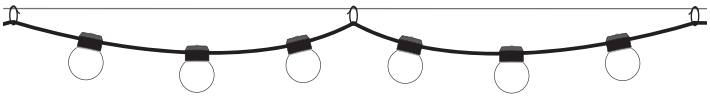


Facade



Straight (shown with DLDLSWRAP) Recommended

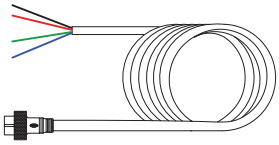
Swayed



INTELLISTRAND RGB

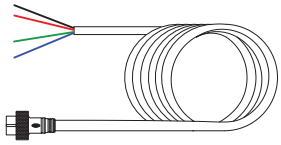
7 - CONNECTION CABLE (REQUIRED)

Length of connection cables must be included in max length calculation



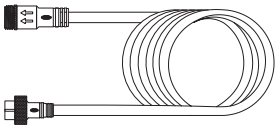
DMX / Power Lead cable 3ft length with 4-pole female connector.

Finish	Black
Part No.	**INTEL06**



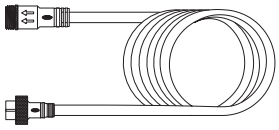
DMX / Power Lead cable 20ft length with 4-pole female connector.

Finish	Black
Part No.	**INTEL33**



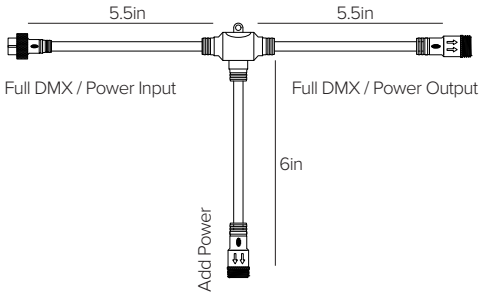
DMX / Power Jumper cable 8ft length with 1ea 4-pole female connector and 4-pole male connector.

Finish	Black
Part No.	**INTEL66**



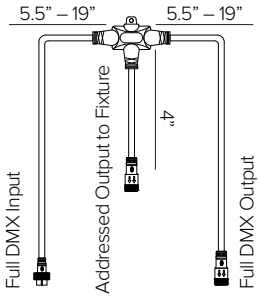
DMX / Power Jumper cable 16ft length with 1ea 4-pole female connector and 4-pole male connector.

Finish	Black
Part No.	**INTEL31**



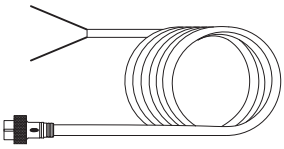
Power Add T-split cable with 1ea 4-pole female connector, 4-pole male connector and 2-pole male connector.

Finish	Black
Part No.	**INTEL07**



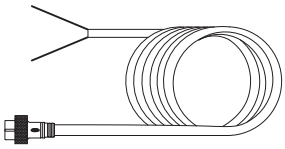
Addressable DMX T-split cable. 2ea 4-pole female connectors and 1ea 4-pole male connector. **Must be factory programmed to specific address requirements.**

Finish	Black
Part No.	**INTEL32**



Low voltage Lead cable 10ft length with 2-pole female connector.

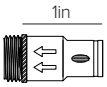
Finish	Black
Part No.	**INTEL09**



Low voltage Lead cable 20ft length with 2-pole female connector.

Finish	Black
Part No.	**INTEL19**

8 - END CAP (REQUIRED)

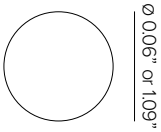


End cap. 4-Pole Male DMX termination.

Finish	Black
Part No.	**INTEL08**

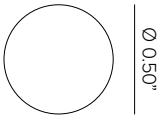
INTELLISTRAND RGB

9 - MOUNTING (OPTIONAL)



Stainless steel aircraft cable, available per foot. **Recommended 1/16" aircraft cable for wall to wall installation configurations, 3/32" aircraft cable for pole to pole installation configurations. For straight/taught installations, add an additional 5ft to each run for fixing lead and end connections.**

Load	1/16" Dia., up to 70Lbs load	3/32" Dia., up to 150Lbs load
Weight	1/16" SS Cable 0.0085 lbs/ft	3/32" SS Cable0.02 lbs/ft
Part No.	**DLDCLAC1-16SS**	**DLDCLAC3-32SS**



Spiral cable wrap, available per foot.
To be used with aircraft cable to encase aircraft cable and DURALED LIGHT CABLE for a clean one wire look. 1.5ft of wrap needed to span evenly per 1ft of cable.

Finish	● Black
Part No.	**DLDLSWRAP**

10 - POWER SUPPLY (REQUIRED)

STANDALONE							
Part No.	*Wattage*	*Dim Range*	*Rating*	*In / Out Voltage*	*Certification*	*Dimensions (Standalone)*	*Description*
DEL10013524	*96W*	Non-Dimmable	IP67	120-277V / 24V	UR Class 2	8.66" x 2.68" x 1.53"	Mean Well HLG electronic power supply. **UL listed enclosure provided by others.**

12 – CONTROL (OPTIONAL)

Part No.		*Channels*	*Scenes*	*Zones*	*Rating*	*Voltage*	*Certification*	*Dimensions*	*Description*
TGDMXSLESAU9		256	20	1	Indoor	5.5V DC	ETL, UL	5.3"W x 5.5"H x 1.9D	Nicolaudie Slesa smart DMX 1/2 universe programmable controller with easy to use software interface.
TGDMXSLESAU11		1024	99	5	Indoor	5VDC 120V AC *Plug in power supply included*	ETL	6.3" x 3.6" x 1.8"	Nicolaudie Slesa smart DMX interface, 2 DMX 512 universes, intuitive backlit keyboard programmable controller with easy to use software interface.
TGDMXSTICKDE3B		1024	500	10	Indoor	6-7V DC 120V AC *Plug in power supply included*	ETL	5.8" x 4.2" x 0.5"	Nicolaudie intelligent control keypad with glass touch sensitive graphic display, stand-alone DMX 512, 2 universe programmable controller with easy to use software interface. Black finish.
TGDMXSTICKDE3W		1024	500	10	Indoor	6-7V DC 120V AC *Plug in power supply included*	ETL	5.8" x 4.2" x 0.5"	Nicolaudie intelligent control keypad with glass touch sensitive graphic display, stand-alone DMX 512, 2 universe programmable controller with easy to use software interface. White finish.

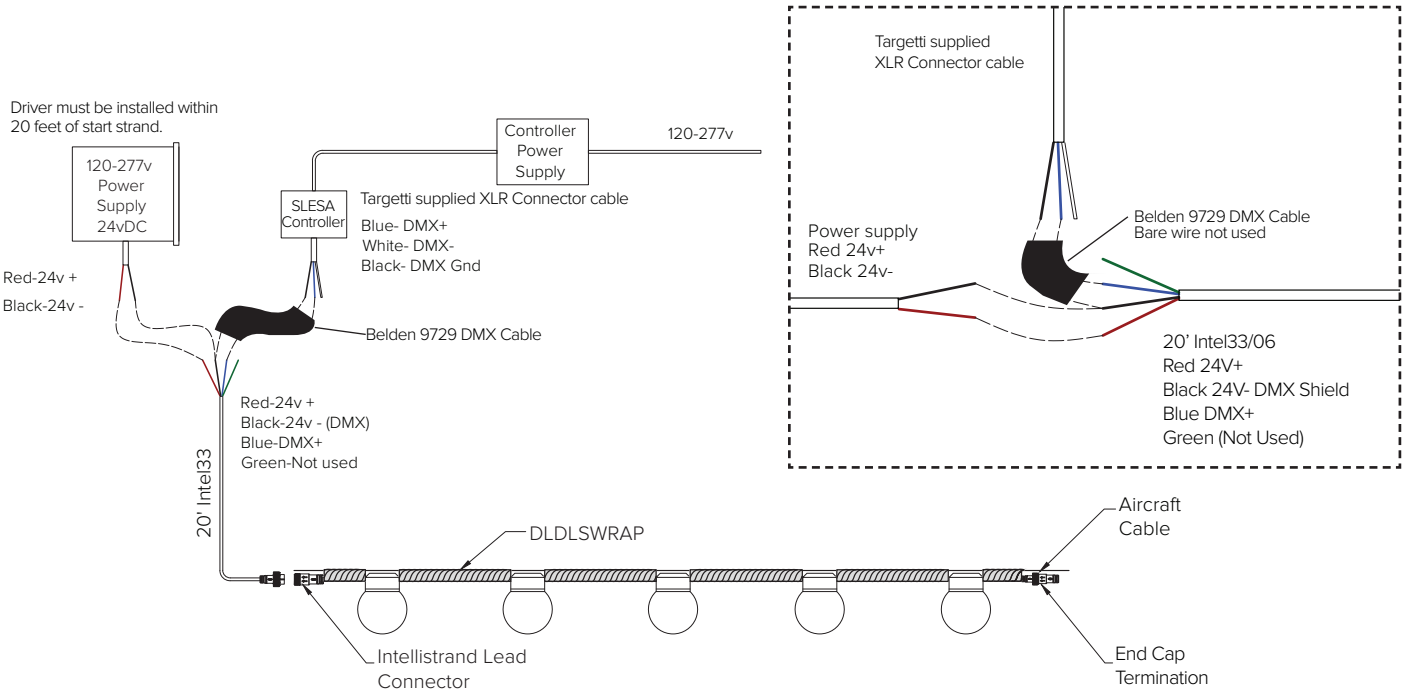
13 - DECORATIVE (OPTIONAL)

Decorative aluminum shade accessory. Weight: 1.6 oz.

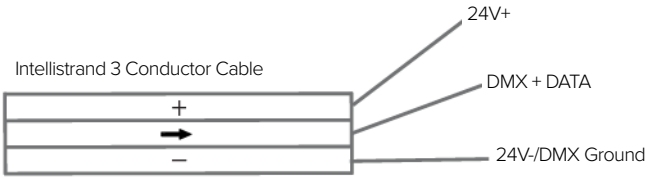
Finish	● Gloss Black
Part No.	**INCLSHADEBK**

INTELLISTRAND RGB

SYSTEM LAYOUT EXAMPLE DIAGRAM



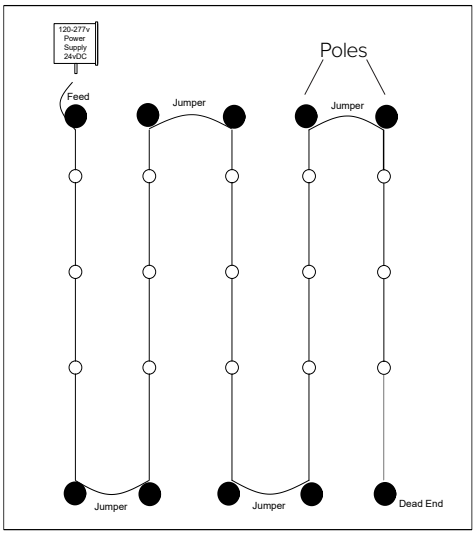
3rd Part DMX 512 configuration Belden 9729 recommended

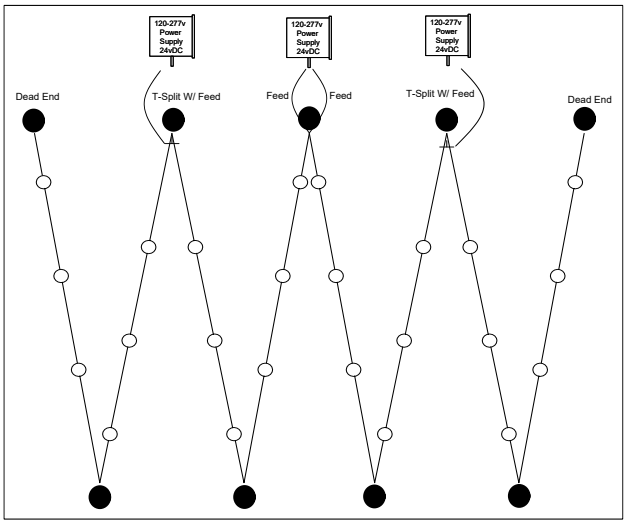


Intellistrand product is directional and must be installed with factory connectors to ensure proper operation.

POSSIBLE CONFIGURATIONS

Targetti USA can supply project specific wiring diagrams upon request.

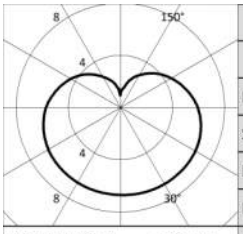




INTELLISTRAND RGB

PHOTOMETRY

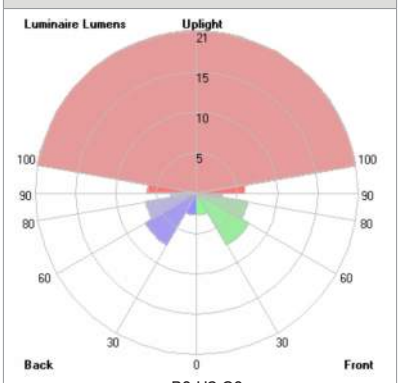
IES FILES WATTAGE AND EFFICIENCY CALCULATIONS BASED WITH SUPPLIED DRIVER



INCL1RGB24

RGB	
–	
Fixture Power	1W
Source Flux	45lm
Fixture Flux	45lm
Efficacy	40.9lm/W
Imax	4.51cd

LCS Graph



B0-U2-G0

Features

Kurba Small is a direct view, small profile, energy efficient and flexible LED strip suitable for outdoor wet locations capable of horizontal/side bends and vertical/top bends with a 2″ bending radius. The silicone material offers excellent heat, weather, UV, and solvent resistance and has a special coating to repel dust and dirt accumulation.

Applications
Indoor/Outdoor dry & wet location

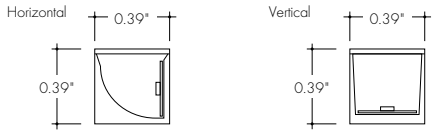
Materials
Silicone for red list approved, as well as heat, weather, UV, and solvent resistance

Dimming
Dot Free even illumination. Also available with Black Lens

Average Life (L70)
50,00 Hours

Approvals
24VDC Class 2 wet listed, IP67

Warranty
3 years



Finish Options (see page 2 for additional information)

Base ☐ White

Premium ■ Black

Technical Information

Bending Direction	Horizontal		Vertical		
Output	**44SO**	**44HO**	**44SO**	**44HO**	**60SO** (Black Lens Only)
Light Output at 3000K	85 lm/ft	163 lm/ft	96 lm/ft	180 lm/ft	16 lm/ft
Average Power Consumption at 4'	1.37 W/ft	2.74 W/ft	1.37 W/ft	2.74 W/ft	1.37 W/ft
Efficacy	62 lm/W	59 lm/W	70 lm/W	66 lm/W	12 lm/W
Ordering Increment	3.28″		3.28″		1.4″
Maximum Run Length (In Series)	49′	24′	49′	24′	33′
Operating Temperature	-40°F to 149°F	-40°F to 131°F	-40°F to 149°F	-40°F to 131°F	-40°F to 149°F

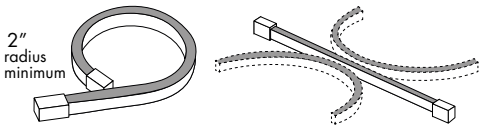
CCT INFO / LUMEN MULTIPLIER

Color Temperature	Multiplier (ref. -3000K)
2200K	0.93
2400K	1.00
2700K	1.00
3000K	1.06
3500K	1.06
4000K	1.00

Note: 80 CRI

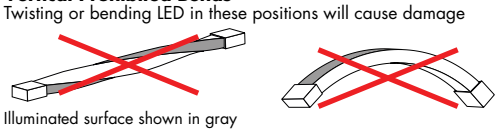
Constraints

Horizontal Bend Direction
Bend LED in these positions only to avoid damage



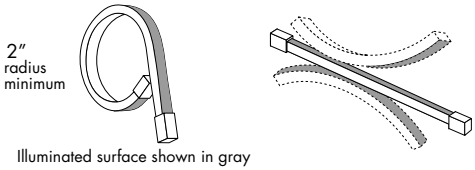
Illuminated surface shown in gray

Vertical Prohibited Bends
Twisting or bending LED in these positions will cause damage



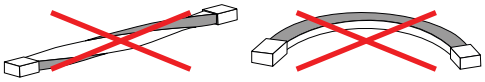
Illuminated surface shown in gray
Do not make sharp bends near the endcap

Vertical Bend Direction
Bend LED in these positions only to avoid damage



Illuminated surface shown in gray

Horizontal Prohibited Bends
Twisting or bending LED in these positions will cause damage



Illuminated surface shown in gray
Do not make sharp bends near the endcap

Ordering Code

MODEL	RATING	BEND DIRECTION	LENGTH	OUTPUT[1]	CCT	LENS[2]	MOUNTING	FINISH	FEED POSITION LEFT	FEED POSITION RIGHT
KBS - Kurba Small	W - Wet	HB - Horizontal Bending VB - Vertical Bending	SEE PCC CHART ON PAGES 6 AND 8	44SO - Standard 44HO - High	22K - 2200K 24K - 2400K 27K - 2700K 30K - 3000K 35K - 3500K 40K - 4000K	SF - Silicone Frosted	NA - See Page 4 for orderable mounting accessories	WH - White	INJECTION MOLD IME - End Feed 1 IMB - Back Feed 1 IMSA - Side 1 Feed IMSB - Side 2 Feed[3] NPF - No Power Feed[4]	INJECTION MOLD IME - End Feed 1 IMB - Back Feed 1 IMSA - Side 1 Feed IMSB - Side 2 Feed[3] NPF - No Power Feed[4]
				60SO - Standard	26K - 2600K 42K - 4200K	BL - Black Lens[2]	NA - See Page 4 for orderable mounting accessories	BK - Black		

Feeds come with 118″ wire leads

1 - Title 24 JA8 compliance achievable, contact factory for specific requests
2 - **BL** Lens only available with **VB** - Vertical Bend Direction
3 - **IMSB** - Side 2 Feed not available with **HB** - Horizontal Bending
4 - **NPF-NPF** for Feed Position 1&2 is not a valid configuration option

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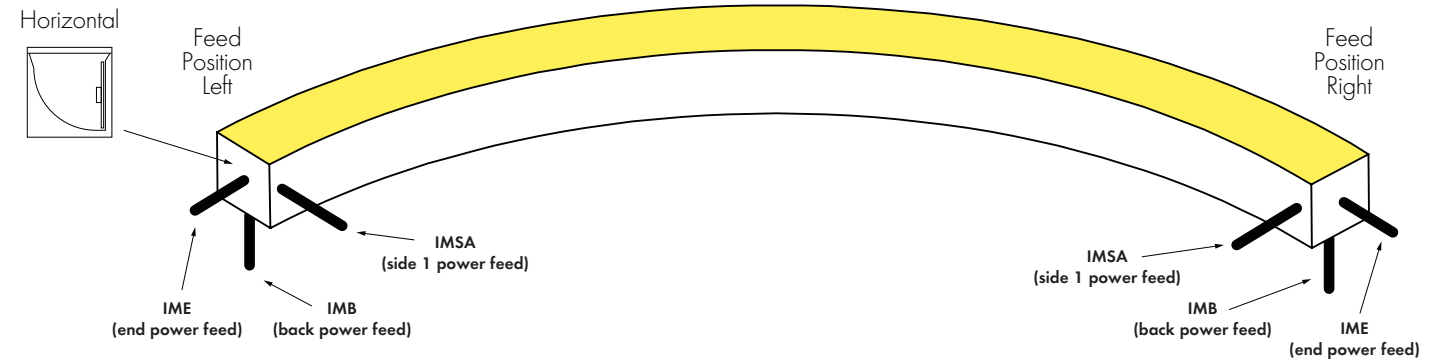
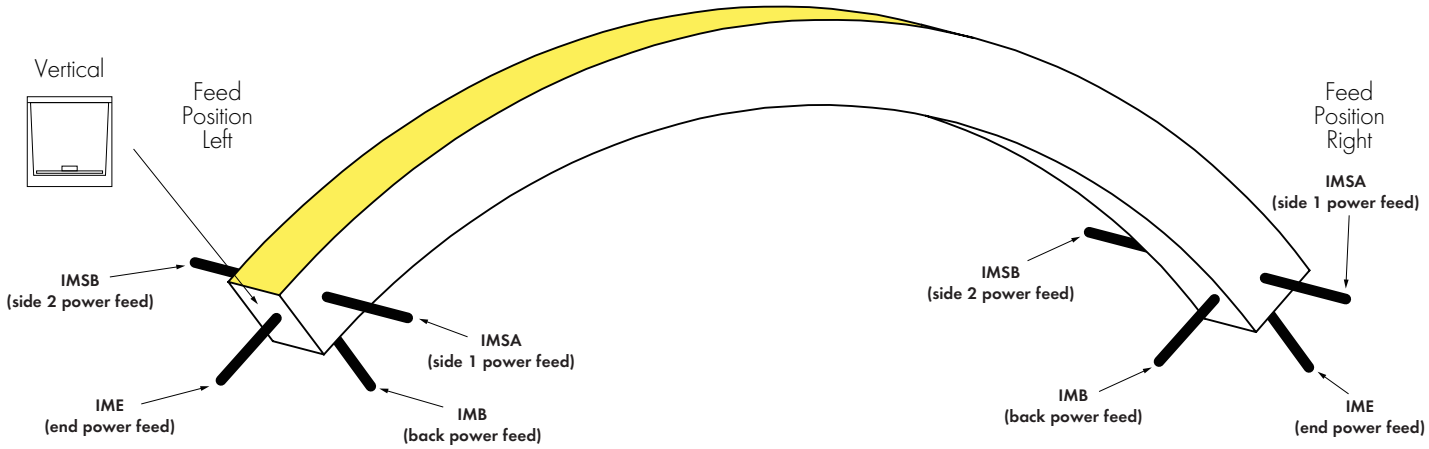
www.luminii.com T: 224-333-6033

Powerfeeds and Connectors

Power Feed Position Options and Orientation

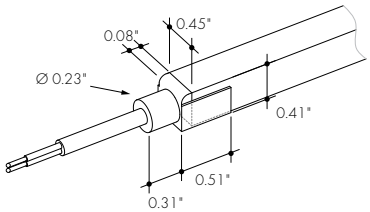




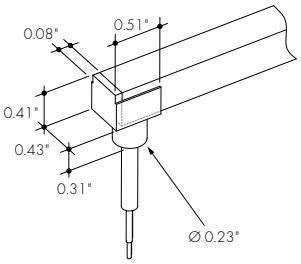
NOTE: IMSB - Side 2 Feed not available with HB - Horizontal Bending

Linking and Extension Cable Options

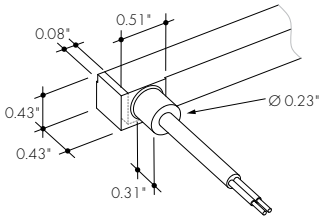
END CONNECTOR
Injection-molded End Connector
-IME



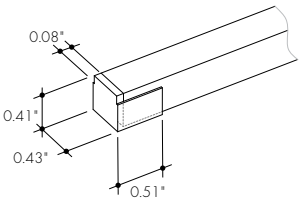
BACK CONNECTOR
Injection-molded Back Connector
-IMB



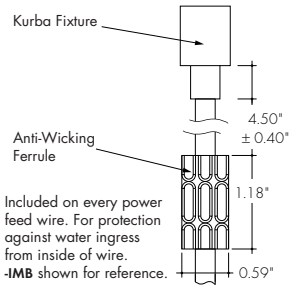
SIDE CONNECTOR
Injection-molded Side Connector
-IMSA and **-IMSB**



ENDCAP (NO CONNECTOR)
Injection-molded Cap (No Connector)
-NPF



ANTI-WICKING FERRULE
Included on every power feed wire



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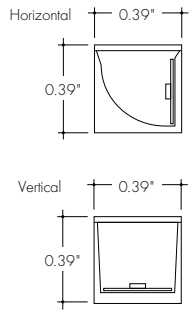
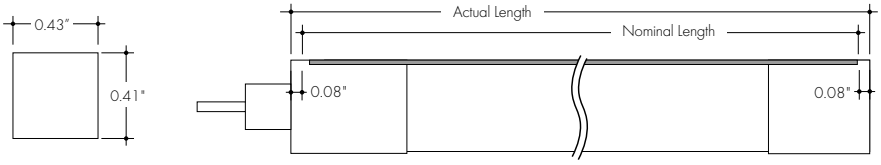
Product Dimensions

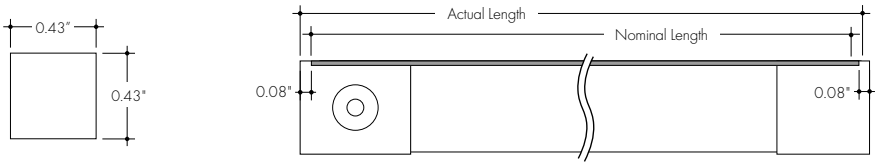
Kurba Small Cross Sections



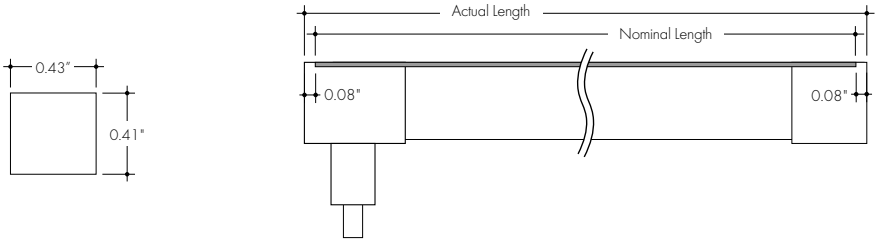
Example Feed Position
IME - NPF
End Feed 1 to
No Power Feed



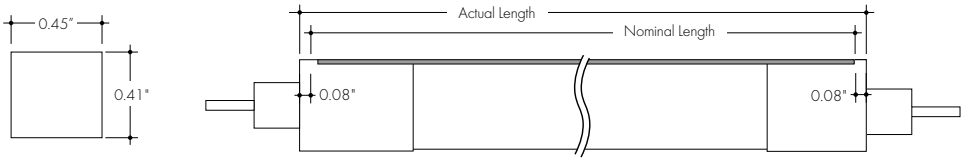
Example Feed Position
IMSA - NPF
Side A Feed to
No Power Feed



Example Feed Position
IMB - NPF
Back Feed 1 to
No Power Feed



Example Feed Position
IME - IME
End Feed 1 and
End Feed 1

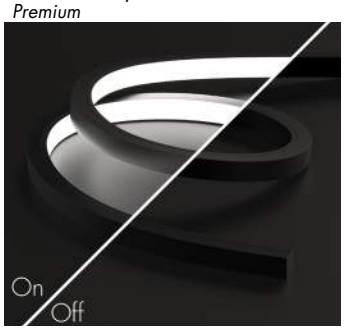


Finish Options

- Kurba's base finish is a crisp white which brings a timeless, clean aesthetic that brightens and enhances any space.
- Also available with a blackout aesthetic - the Black Lens paired with the Black Finish provides for a sleek, all black profile that keeps the strip concealed in the off-state.

White
Base

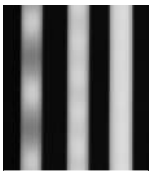
Black Finish w/ Black Lens
Premium



*LUMINII RESERVES THE RIGHTS TO CHANGE SPECIFICATION & INSTRUCTION WITHOUT NOTICE

Light Transmission and Dotting

Output Options	Lens/Accessory: Silicone Frosted/ White Finish	Lens/Accessory: Black Lens/ Black Finish
44SO	ND	N/A
44HO	ND	N/A
60SO	N/A	ND
Transmission Percentage	100%	100%

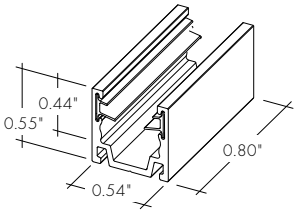


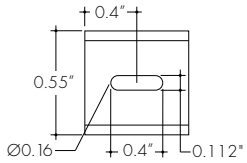
CD **SD** **ND**

CD - Clear Dotting
SD - Slight Dotting
ND - No Dotting

Mounting Accessories & Optional Connectors

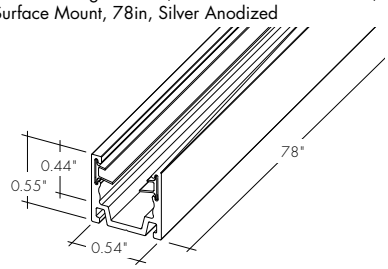
MC-KBS-SAP-SM-0.8-SA
KBS Mounting Channel, Serrated Aluminum Profile, Surface Mount, 0.8in, Silver Anodized

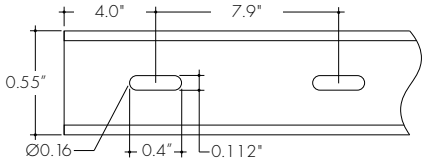




Aluminum mounting bracket providing grip. For use with light strip mounted to the ceiling. 1 recommended every 8 in.

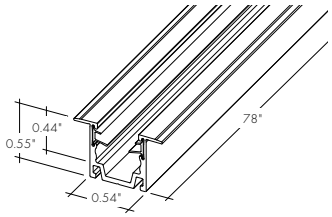
MC-KBS-SAP-SM-78-SA
KBS Mounting Channel, Serrated Aluminum Profile, Surface Mount, 78in, Silver Anodized

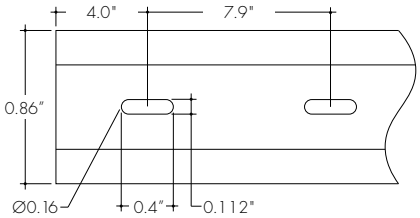




Aluminum mounting channel providing grip. For use with light strip mounted to the ceiling.

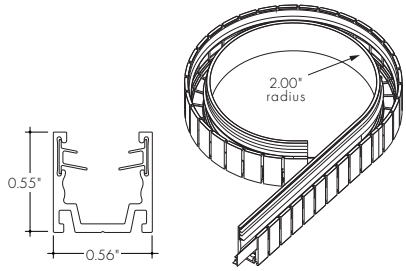
MC-KBS-FSAP-TR-78-SA
KBS Mounting Channel, Flanged Serrated Aluminum Profile, Trimmed Recessed Mount, 78in, Silver Anodized

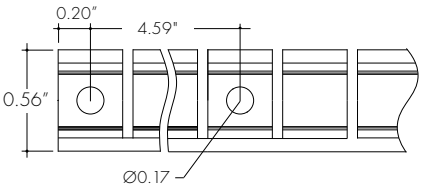




Flanged aluminum mounting channel providing grip. For use with light strip mounted to the ceiling.

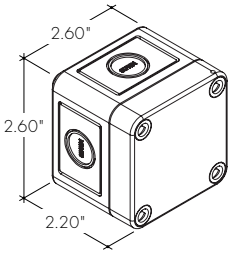
MC-KBS-BSAP-HB-SM-38-SA
KBS Mounting Channel, Bendable Serrated Aluminum Profile, Horizontal Bending, Surface Mount, 38in, Silver Anodized



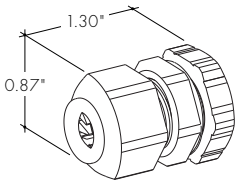


For use with light strip mounted to the ceiling.
NOTE: For use with **HB** - Horizontal Bend only. Mounting Channel Bending Radius is 7.87" in opposite direction

LVSP-WET
Splice box: wet rated, low voltage, gray



LVSP-WET-CM
Connector for splice box, low voltage for cable management, gray



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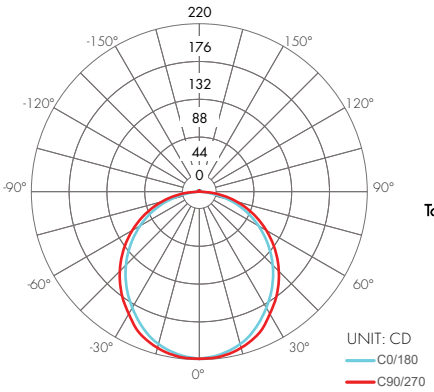
Photometry

KBS-W-HB-48-44HO-30K-R80-SF-NA-WH

Kurba Small, Horizontal Bend, 4ft, 3000K, 80 CRI, 44HO, Silicone Frosted Lens



Zonal Lumen Summary 3000K

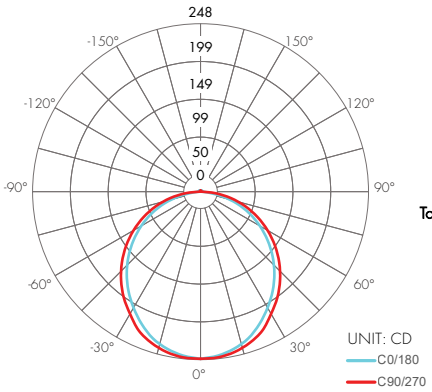
Zone	Lumen	% Fixture
0-30	170	26.0%
0-40	233	35.7%
0-60	491	75.2%
0-90	639	98.0%
Total 0-180	652	100.0%

Beam Angle

112°

KBS-W-VB-48-44HO-30K-R80-SF-NA-WH

Kurba Small, Vertical Bend, 4ft, 3000K, 80 CRI, 44HO, Silicone Frosted Lens



Zonal Lumen Summary 3000K

Zone	Lumen	% Fixture
0-30	191	26.5%
0-40	262	36.4%
0-60	552	76.6%
0-90	709	98.5%
Total 0-180	720	100.0%

Beam Angle

112°

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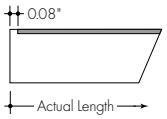
44SO | Power Consumption Per Fixture Length

Based on operation with PDCU series of power supplies. Use Acutal Length for Order Code Entry
Tolerance for Actual Lengths less than 6 ft is +/- 0.2", Actual Lengths between 6 ft and 16 ft is +/- 0.3", and Actual Lengths greater than 16 ft is +/- 0.6"

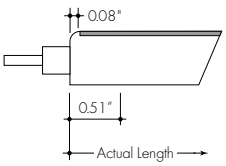
Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)
7	0.8	6.7	125	14.3	124.8	243	27.8	242.9	(30 ft) 361	41.3	361.0	(40 ft) 479	54.8	479.1
10	1.1	10.0	128	14.6	128.1	246	28.1	246.2	365	41.7	364.3	483	55.2	482.4
(1 ft) 14	1.5	13.3	(11 ft) 132	15.0	131.4	250	28.5	249.5	368	42.0	367.6	486	55.5	485.7
17	1.9	16.6	135	15.4	134.7	(21 ft) 253	28.9	252.8	(31 ft) 371	42.4	370.9	489	55.9	489.0
20	2.3	19.8	138	15.8	137.9	256	29.3	256.1	374	42.8	374.2	(41 ft) 493	56.3	492.3
(2 ft) 23	2.6	23.1	141	16.1	141.2	260	29.6	259.3	378	43.2	377.4	496	56.7	495.5
27	3.0	26.4	(12 ft) 145	16.5	144.5	(22 ft) 263	30.0	262.6	381	43.5	380.7	499	57.0	498.8
30	3.4	29.7	148	16.9	147.8	266	30.4	265.9	(32 ft) 384	43.9	384.0	502	57.4	502.1
33	3.8	33.0	151	17.3	151.1	269	30.8	269.2	388	44.3	387.3	(42 ft) 506	57.8	505.4
(3 ft) 36	4.1	36.2	(13 ft) 155	17.6	154.4	273	31.2	272.5	391	44.7	390.6	509	58.2	508.7
40	4.5	39.5	158	18.0	157.6	(23 ft) 276	31.5	275.7	394	45.0	393.8	512	58.5	512.0
43	4.9	42.8	161	18.4	160.9	279	31.9	279.0	(33 ft) 397	45.4	397.1	(43 ft) 515	58.9	515.2
46	5.3	46.1	164	18.8	164.2	282	32.3	282.3	401	45.8	400.4	519	59.3	518.5
(4 ft) 50	5.6	49.4	(14 ft) 168	19.1	167.5	286	32.7	285.6	404	46.2	403.7	522	59.7	521.8
53	6.0	52.7	171	19.5	170.8	(24 ft) 289	33.0	288.9	(34 ft) 407	46.5	407.0	525	60.0	525.1
56	6.4	55.9	174	19.9	174.0	292	33.4	292.1	410	46.9	410.2	(44 ft) 529	60.4	528.4
(5 ft) 59	6.8	59.2	178	20.3	177.3	296	33.8	295.4	414	47.3	413.5	532	60.8	531.6
63	7.1	62.5	(15 ft) 181	20.6	180.6	(25 ft) 299	34.2	298.7	417	47.7	416.8	535	61.2	534.9
66	7.5	65.8	184	21.0	183.9	302	34.5	302.0	(35 ft) 420	48.0	420.1	(45 ft) 538	61.5	538.2
69	7.9	69.1	187	21.4	187.2	305	34.9	305.3	424	48.4	423.4	542	61.9	541.5
(6 ft) 73	8.3	72.3	(16 ft) 191	21.8	190.4	309	35.3	308.5	427	48.8	426.7	545	62.3	544.8
76	8.6	75.6	194	22.1	193.7	(26 ft) 312	35.7	311.8	430	49.2	429.9	548	62.7	548.0
79	9.0	78.9	197	22.5	197.0	315	36.0	315.1	(36 ft) 433	49.5	433.2	(46 ft) 552	63.0	551.3
(7 ft) 82	9.4	82.2	200	22.9	200.3	319	36.4	318.4	437	49.9	436.5	555	63.4	554.6
86	9.8	85.5	(17 ft) 204	23.3	203.6	322	36.8	321.7	440	50.3	439.8	558	63.8	557.9
89	10.1	88.7	207	23.6	206.8	(27 ft) 325	37.2	325.0	(37 ft) 443	50.7	443.1	561	64.2	561.2
92	10.5	92.0	210	24.0	210.1	328	37.5	328.2	447	51.0	446.3	(47 ft) 565	64.5	564.4
(8 ft) 96	10.9	95.3	214	24.4	213.4	332	37.9	331.5	450	51.4	449.6	568	64.9	567.7
99	11.3	98.6	(18 ft) 217	24.8	216.7	(28 ft) 335	38.3	334.8	453	51.8	452.9	571	65.3	571.0
102	11.6	101.9	220	25.1	220.0	338	38.7	338.1	(38 ft) 456	52.2	456.2	(48 ft) 575	65.7	574.3
105	12.0	105.1	223	25.5	223.2	342	39.0	341.4	460	52.5	459.5	578	66.0	577.6
(9 ft) 109	12.4	108.4	(19 ft) 227	25.9	226.5	345	39.4	344.6	463	52.9	462.7	581	66.4	580.8
112	12.8	111.7	230	26.3	229.8	(29 ft) 348	39.8	347.9	466	53.3	466.0	584	66.8	584.1
115	13.1	115.0	233	26.6	233.1	351	40.2	351.2	(39 ft) 470	53.7	469.3	(49ft) 588	67.2	587.4
(10 ft) 118	13.5	118.3	237	27.0	236.4	355	40.5	354.5	473	54.0	472.6			
122	13.9	121.5	(20 ft) 240	27.4	239.7	358	40.9	357.8	476	54.4	475.9			

Note: all values are rounded to the nearest 0.1 inch

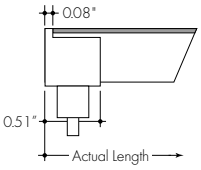
Endcap (No Connector) -NPF



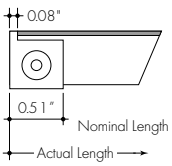
End Connector -IME



Back Connector -IMB



Side Connector -IMSA and -IMSB



*LUMINII RESERVES THE RIGHTS TO CHANGE SPECIFICATION & INSTRUCTION WITHOUT NOTICE

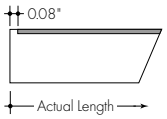
44HO | Power Consumption Per Fixture Length

Based on operation with PDCU series of power supplies. Use Acutal Length for Order Code Entry
Tolerance for Actual Lengths less than 6 ft is +/- 0.2", Actual Lengths between 6 ft and 16 ft is +/- 0.3", and Actual Lengths greater than 16 ft is +/- 0.6"

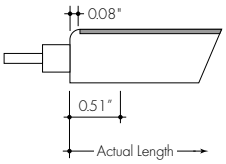
Nominal Length (in)	W	**Actual Length (in)**	Nominal Length (in)	W	**Actual Length (in)**	Nominal Length (in)	W	**Actual Length (in)**
7	**1.5**	6.7	**125**	**28.5**	124.8	**243**	**55.5**	242.9
10	**2.3**	10.0	**128**	**29.3**	128.1	**246**	**56.3**	246.2
(1 ft) 14	**3.0**	13.3	**(11 ft) 132**	**30.0**	131.4	**250**	**57.0**	249.5
17	**3.8**	16.6	**135**	**30.8**	134.7	**(21 ft) 253**	**57.8**	252.8
20	**4.5**	19.8	**138**	**31.5**	137.9	**256**	**58.5**	256.1
(2 ft) 23	**5.3**	23.1	**141**	**32.3**	141.2	**260**	**59.3**	259.3
27	**6.0**	26.4	**(12 ft) 145**	**33.0**	144.5	**(22 ft) 263**	**60.0**	262.6
30	**6.8**	29.7	**148**	**33.8**	147.8	**266**	**60.8**	265.9
33	**7.5**	33.0	**151**	**34.5**	151.1	**269**	**61.5**	269.2
(3 ft) 36	**8.3**	36.2	**(13 ft) 155**	**35.3**	154.4	**273**	**62.3**	272.5
40	**9.0**	39.5	**158**	**36.0**	157.6	**(23 ft) 276**	**63.1**	275.7
43	**9.8**	42.8	**161**	**36.8**	160.9	**279**	**63.8**	279.0
46	**10.5**	46.1	**164**	**37.5**	164.2	**282**	**64.6**	282.3
(4 ft) 50	**11.3**	49.4	**(14 ft) 168**	**38.3**	167.5	**286**	**65.3**	285.6
53	**12.0**	52.7	**171**	**39.0**	170.8	**(24 ft) 289**	**66.1**	288.9
56	**12.8**	55.9	**174**	**39.8**	174.0	**292**	**66.8**	292.1
(5 ft) 59	**13.5**	59.2	**178**	**40.5**	177.3	**296**	**67.6**	295.4
63	**14.3**	62.5	**(15 ft) 181**	**41.3**	180.6			
66	**15.0**	65.8	**184**	**42.0**	183.9			
69	**15.8**	69.1	**187**	**42.8**	187.2			
(6 ft) 73	**16.5**	72.3	**(16 ft) 191**	**43.5**	190.4			
76	**17.3**	75.6	**194**	**44.3**	193.7			
79	**18.0**	78.9	**197**	**45.0**	197.0			
(7 ft) 82	**18.8**	82.2	**200**	**45.8**	200.3			
86	**19.5**	85.5	**(17 ft) 204**	**46.5**	203.6			
89	**20.3**	88.7	**207**	**47.3**	206.8			
92	**21.0**	92.0	**210**	**48.0**	210.1			
(8 ft) 96	**21.8**	95.3	**214**	**48.8**	213.4			
99	**22.5**	98.6	**(18 ft) 217**	**49.5**	216.7			
102	**23.3**	101.9	**220**	**50.3**	220.0			
105	**24.0**	105.1	**223**	**51.0**	223.2			
(9 ft) 109	**24.8**	108.4	**(19 ft) 227**	**51.8**	226.5			
112	**25.5**	111.7	**230**	**52.5**	229.8			
115	**26.3**	115.0	**233**	**53.3**	233.1			
(10 ft) 118	**27.0**	118.3	**237**	**54.0**	236.4			
122	**27.8**	121.5	**(20 ft) 240**	**54.8**	239.7			

Note: all values are rounded to the nearest 0.1 inch

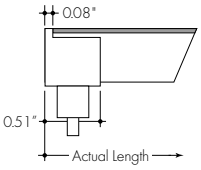
Endcap (No Connector) -NPF



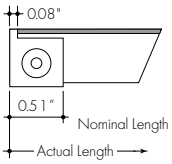
End Connector -IME



Back Connector -IMB



Side Connector -IMSA and -IMSB



*LUMINII RESERVES THE RIGHTS TO CHANGE SPECIFICATION & INSTRUCTION WITHOUT NOTICE

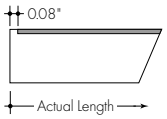
60SO | Power Consumption Per Fixture Length

Based on operation with PDCU series of power supplies. Use Acutal Length for Order Code Entry
Tolerance for Actual Lengths less than 6 ft is +/- 0.2", Actual Lengths between 6 ft and 16 ft is +/- 0.3", and Actual Lengths greater than 16 ft is +/- 0.6"

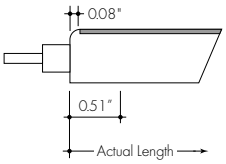
Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)
7	0.8	7.2	58	6.6	57.8	(8ft) 109	12.4	108.4	159	18.2	159.0	210	24.0	209.6
8	1.0	8.6	59	6.8	59.2	110	12.6	109.8	161	18.3	160.4	211	24.1	211.0
10	1.1	10.0	(5ft) 60	6.9	60.6	111	12.7	111.2	162	18.5	161.8	212	24.3	212.4
11	1.3	11.4	62	7.1	62.0	113	12.9	112.6	163	18.7	163.2	214	24.4	213.8
(1ft) 13	1.5	12.8	63	7.2	63.4	114	13.0	114.0	165	18.8	164.6	215	24.6	215.2
14	1.6	14.2	65	7.4	64.8	116	13.2	115.4	166	19.0	166.0	(18ft) 217	24.8	216.6
16	1.8	15.6	66	7.6	66.2	117	13.4	116.8	(14ft) 168	19.1	167.4	218	24.9	218.0
17	1.9	17.0	68	7.7	67.6	118	13.5	118.2	169	19.3	168.8	220	25.1	219.4
19	2.1	18.4	69	7.9	69.0	(10ft) 120	13.7	119.6	170	19.5	170.2	221	25.2	220.8
20	2.3	19.8	71	8.1	70.4	121	13.8	121.0	172	19.6	171.6	222	25.4	222.2
21	2.4	21.2	(6ft) 72	8.2	71.8	123	14.0	122.4	173	19.8	173.0	224	25.6	223.6
23	2.6	22.6	73	8.4	73.2	124	14.2	123.8	175	19.9	174.4	225	25.7	225.0
(2ft) 24	2.8	24.1	75	8.5	74.7	125	14.3	125.3	176	20.1	175.8	227	25.9	226.4
25	2.9	25.5	76	8.7	76.1	127	14.5	126.7	177	20.3	177.3	(19ft) 228	26.1	227.9
26	3.1	26.9	78	8.9	77.5	128	14.6	128.1	179	20.4	178.7	229	26.2	229.3
28	3.2	28.3	79	9.0	78.9	130	14.8	129.5	(15ft) 180	20.6	180.1	231	26.4	230.7
30	3.4	29.7	80	9.2	80.3	131	15.0	130.9	182	20.7	181.5	232	26.5	232.1
31	3.6	31.1	82	9.3	81.7	(11ft) 132	15.1	132.3	183	20.9	182.9	234	26.7	233.5
32	3.7	32.5	83	9.5	83.1	134	15.3	133.7	184	21.1	184.3	235	26.9	234.9
34	3.9	33.9	(7ft) 85	9.7	84.5	135	15.4	135.1	186	21.2	185.7	236	27.0	236.3
35	4.0	35.3	86	9.8	85.9	137	15.6	136.5	187	21.4	187.1	238	27.2	237.7
(3ft) 37	4.2	36.7	87	10.0	87.3	138	15.8	137.9	189	21.6	188.5	239	27.3	239.1
38	4.4	38.1	89	10.1	88.7	139	15.9	139.3	190	21.7	189.9	(20ft) 241	27.5	240.5
39	4.5	39.5	90	10.3	90.1	141	16.1	140.7	191	21.9	191.3	242	27.7	241.9
41	4.7	40.9	92	10.5	91.5	142	16.2	142.1	(16ft) 193	22.0	192.7	243	27.8	243.3
42	4.8	42.3	93	10.6	92.9	(12ft) 144	16.4	143.5	194	22.2	194.1	245	28.0	244.7
44	5.0	43.7	94	10.8	94.3	145	16.6	144.9	196	22.4	195.5	246	28.1	246.1
45	5.2	45.1	(8ft) 96	10.9	95.7	146	16.7	146.3	197	22.5	196.9	248	28.3	247.5
46	5.3	46.5	97	11.1	97.1	148	16.9	147.7	198	22.7	198.3	249	28.5	248.9
(4ft) 48	5.5	47.9	99	11.3	98.5	149	17.1	149.1	200	22.8	199.7	251	28.6	250.3
49	5.6	49.4	100	11.4	100.0	151	17.2	150.5	201	23.0	201.1	(21ft) 252	28.8	251.7
51	5.8	50.8	102	11.6	101.4	152	17.4	152.0	203	23.2	202.6	253	28.9	253.2
52	6.0	52.2	103	11.7	102.8	153	17.5	153.4	(17ft) 204	23.3	204.0	255	29.1	254.6
53	6.1	53.6	104	11.9	104.2	155	17.7	154.8	205	23.5	205.4	256	29.3	256.0
55	6.3	55.0	106	12.1	105.6	(13ft) 156	17.9	156.2	207	23.6	206.8			
56	6.4	56.4	107	12.2	107.0	158	18.0	157.6	208	23.8	208.2			

Note: all values are rounded to the nearest 0.1 inch

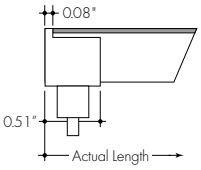
Endcap (No Connector) -NPF



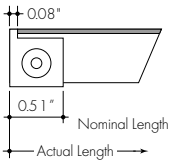
End Connector -IME



Back Connector -IMB



Side Connector -IMSA and -IMSB



*LUMINII RESERVES THE RIGHTS TO CHANGE SPECIFICATION & INSTRUCTION WITHOUT NOTICE

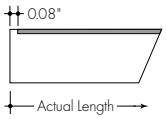
60SO | Power Consumption Per Fixture Length cont.

Based on operation with PDCU series of power supplies. Use Acutal Length for Order Code Entry
Tolerance for Actual Lengths less than 6 ft is +/- 0.2", Actual Lengths between 6 ft and 16 ft is +/- 0.3", and Actual Lengths greater than 16 ft is +/- 0.6"

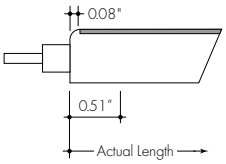
Nominal Length (in)	W	**Actual Length (in)**	Nominal Length (in)	W	**Actual Length (in)**	Nominal Length (in)	W	**Actual Length (in)**
258	**29.4**	257.4	**308**	**35.2**	307.9	**359**	**41.0**	358.5
259	**29.6**	258.8	**310**	**35.4**	309.3	**(30ft) 360**	**41.2**	359.9
260	**29.7**	260.2	**311**	**35.5**	310.7	**361**	**41.3**	361.3
262	**29.9**	261.6	**(26ft) 312**	**35.7**	312.1	**363**	**41.5**	362.7
263	**30.1**	263.0	**314**	**35.9**	313.5	**364**	**41.6**	364.1
(22ft) 265	**30.2**	264.4	**315**	**36.0**	314.9	**366**	**41.8**	365.5
266	**30.4**	265.8	**317**	**36.2**	316.3	**367**	**42.0**	366.9
267	**30.5**	267.2	**318**	**36.3**	317.7	**368**	**42.1**	368.3
269	**30.7**	268.6	**319**	**36.5**	319.1	**370**	**42.3**	369.7
270	**30.9**	270.0	**321**	**36.7**	320.5	**371**	**42.4**	371.1
272	**31.0**	271.4	**322**	**36.8**	321.9	**(31ft) 373**	**42.6**	372.5
273	**31.2**	272.8	**(27ft) 324**	**37.0**	323.3	**374**	**42.8**	373.9
274	**31.4**	274.2	**325**	**37.1**	324.8	**376**	**42.9**	375.4
(23ft) 276	**31.5**	275.6	**326**	**37.3**	326.2	**377**	**43.1**	376.8
277	**31.7**	277.0	**328**	**37.5**	327.6	**378**	**43.2**	378.2
279	**31.8**	278.5	**329**	**37.6**	329.0	**380**	**43.4**	379.6
280	**32.0**	279.9	**331**	**37.8**	330.4	**381**	**43.6**	381.0
281	**32.2**	281.3	**332**	**37.9**	331.8	**383**	**43.7**	382.4
283	**32.3**	282.7	**333**	**38.1**	333.2	**(32ft) 384**	**43.9**	383.8
284	**32.5**	284.1	**335**	**38.3**	334.6	**385**	**44.0**	385.2
286	**32.6**	285.5	**(28ft) 336**	**38.4**	336.0	**387**	**44.2**	386.6
287	**32.8**	286.9	**338**	**38.6**	337.4	**388**	**44.4**	388.0
(24ft) 288	**33.0**	288.3	**339**	**38.7**	338.8	**390**	**44.5**	389.4
290	**33.1**	289.7	**340**	**38.9**	340.2	**391**	**44.7**	390.8
291	**33.3**	291.1	**342**	**39.1**	341.6	**392**	**44.9**	392.2
293	**33.4**	292.5	**343**	**39.2**	343.0	**(33ft) 394**	**45.0**	393.6
294	**33.6**	293.9	**344**	**39.4**	344.4			
296	**33.8**	295.3	**346**	**39.5**	345.8			
297	**33.9**	296.6	**(29ft) 348**	**39.7**	347.2			
298	**34.1**	298.0	**349**	**39.9**	348.6			
(25ft) 300	**34.2**	299.5	**350**	**40.0**	350.1			
301	**34.4**	300.9	**352**	**40.2**	351.5			
302	**34.6**	302.3	**353**	**40.4**	352.9			
304	**34.7**	303.7	**355**	**40.5**	354.3			
305	**34.9**	305.1	**356**	**40.7**	355.7			
307	**35.0**	306.5	**357**	**40.8**	357.1			

Note: all values are rounded to the nearest 0.1 inch

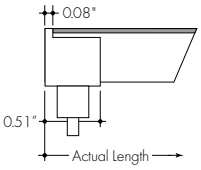
Endcap (No Connector) -NPF



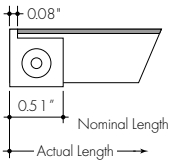
End Connector -IME



Back Connector -IMB



Side Connector -IMSA and -IMSB



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Power Supplies

See Power Supply instructions and spec sheet for wiring information. For a complete list of compatible dimmers, see Compatible Dimming Chart on the Resources page.

For use with Static White

Ordering Code Universal Dimming Power Supplies 1% 120VAC - 277VAC

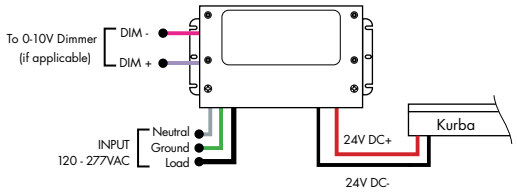
MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT
PS-Power Supply, 120-277VAC	UNI-0-10V Dimming, Phase Dimming	W-Wet	30-30 Watts 60-60 Watts 96-96 Watts 3x96-3x96 Watts	24-24 VDC

Compatibility: View a complete list of compatible dimmers on product page (Link)

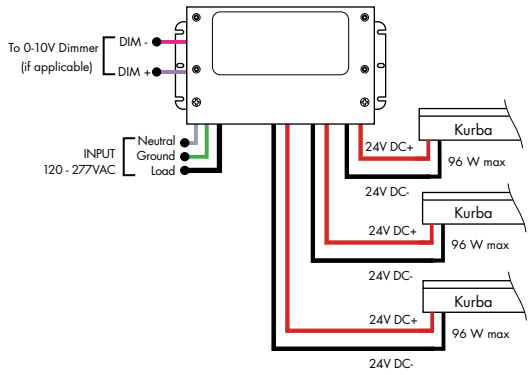
0-10V - 1% dimming
MLV/ELV/TRIAC - 1% dimming, consult dimming compatibility chart

MODELS	PS-UNI-W-30W	PS-UNI-W-60W	PS-UNI-W-96W	PS-UNI-W-3X96W
Length	6.50″	7.40″	8.66"	11.85"
Width	3.73″	3.73″	3.73"	4.32"
Depth	1.61″	1.61″	1.61"	1.81"

PS-UNI-W-96



PS-UNI-W-3X96



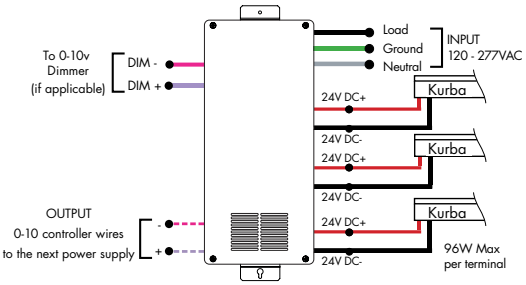
For use with Static White

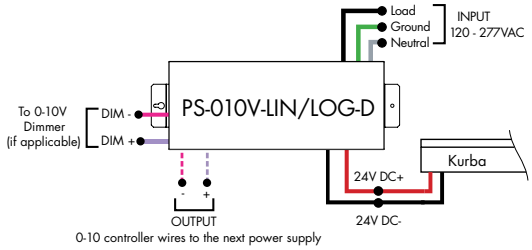
0-10V Dimming Power Supplies 0.1% 120VAC - 277VAC

MODEL	POWER	OUTPUT	INPUT CONTROL	ENVIRONMENT
PS-Power Supply, 120-277VAC	96-96 Watts 3x96-3x96 Watts	24-24 VDC	010V-LIN-0-10V Dimming (0.1%), Linear 010V-LOG-0-10V Dimming (0.1%), Logarithmic	D-Dry

MODELS	96W	3X96
Length	14.40"	15.00"
Width	5.20"	6.62"
Depth	2.60"	4.45"

PS-010V-LIN/LOG-D-3X96





*LUMINII RESERVES THE RIGHTS TO CHANGE SPECIFICATION & INSTRUCTION WITHOUT NOTICE

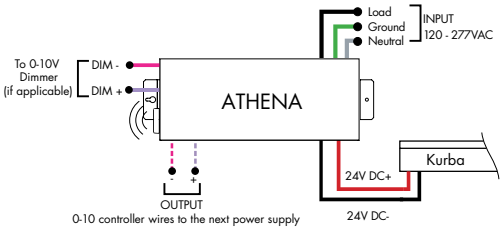
Power Supplies

See Power Supply instructions and spec sheet for wiring information. For a complete list of compatible dimmers, see Compatible Dimming Chart on the Resources page.

For use with Static White

Athena 0-10V LED Driver

MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT	FEATURE
PS-Power Supply, 120-277VAC	010V-LIN-0-10V Dimming (0.1%), Linear 010V-LOG-0-10V Dimming (0.1%), Logarithmic	D-Dry	96-96 Watts	24-24 VDC	AWNR-Athena



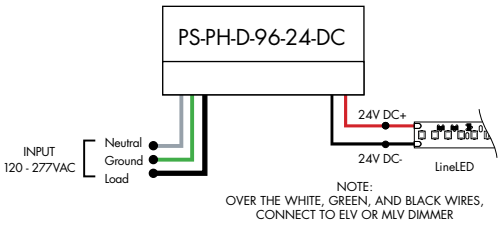
MODELS	96W
Length	14.40"
Width	5.20"
Depth	2.60"

For use with Static White

Ordering Code Phase Dimming Power Supply 1% 120VAC - 277VAC

MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT	OUTPUT CONTROL
PS-Power Supply, 120-277VAC	PH-Phase Dimming (Triac, ELV, MLV)	D-Dry	96-96 Watts	24-24 VDC	DC-Direct Current

MLV/ELV/TRIAC - 1% dimming, consult dimming compatibility chart (Link)



MODELS	96W
Length	8.25"
Width	4.10"
Depth	1.56"

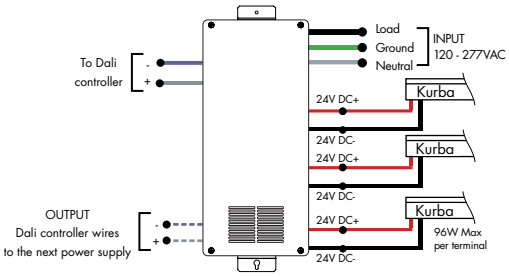
For use with Static White

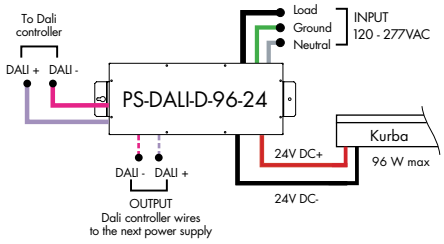
DALI Dimming Power Supplies 0.1% 120VAC - 277VAC

MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT
PS-Power Supply, 120-277VAC	DALI-DALI (0.1%)	D-Dry	96-96 Watts 3x96-3x96 Watts	24-24 VDC

Model	96W	3X96
Length	14.40"	15.00"
Width	5.20"	6.62"
Depth	2.60"	4.56"

PS-DALI-D-3X96-24





*LUMINII RESERVES THE RIGHTS TO CHANGE SPECIFICATION & INSTRUCTION WITHOUT NOTICE

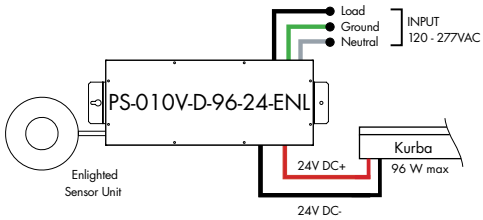
Power Supplies

See Power Supply instructions and spec sheet for wiring information. For a complete list of compatible dimmers, see Compatible Dimming Chart on the Resources page.

For use with Static White

Athena 0-10V LED Driver

MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT	FEATURE
PS-Power Supply, 120-277VAC	010V-0-10V Dimming (1%)	D-Dry	96-96 Watts	24-24 VDC	ENL-0-10V Enlightened



Model	96W
Length	14.40"
Width	5.20"
Depth	2.60"

For use with Static White

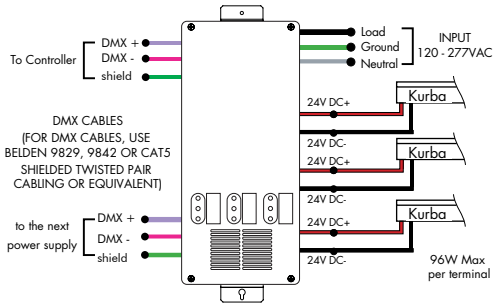
Requires Zonal Control

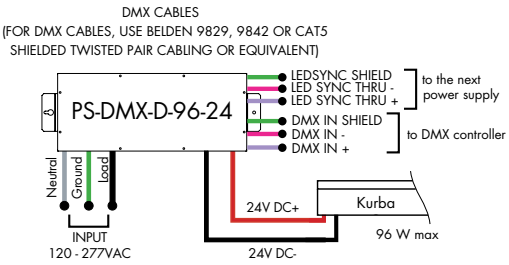
DMX Dimming Power Supplies 0.1% 120VAC - 277VAC

MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT
PS-Power Supply, 120-277VAC	DMX-DMX (0.1%)	D-Dry	96-96 Watts 3x96-3x96 Watts	24-24 VDC

MODELS	96W	3X96
Length	14.40"	15.00"
Width	5.20"	6.62"
Depth	2.60"	4.56"

PS-DMX-D-3X96-24

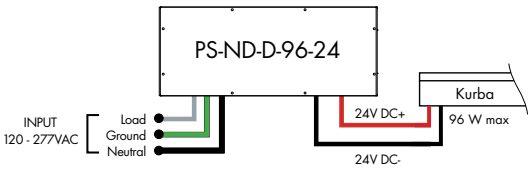




For use with Static White

DMX Dimming Power Supplies 0.1% 120VAC - 277VAC

MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT
PS-Power Supply, 120-277VAC	ND-Non Dimming	D-Dry	96-96 Watts	24-24 VDC



MODELS	96W
Length	14.40"
Width	5.20"
Depth	2.60"

*LUMINII RESERVES THE RIGHTS TO CHANGE SPECIFICATION & INSTRUCTION WITHOUT NOTICE

Power Supplies

See Power Supply instructions and spec sheet for wiring information. For a complete list of compatible dimmers, see Compatible Dimming Chart on the Resources page.

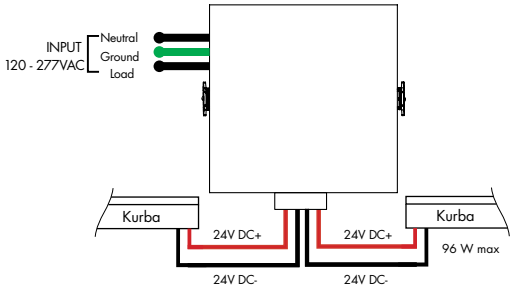
For use with Static White

In-Ground Power Supplies

MODEL		INPUT CONTROL		ENVIRONMENT		WATTAGE		OUTPUT
	-		-		-		-	
PS120-Power Supply, 120VAC PS240-Power Supply, 240VAC PS277-Power Supply, 277VAC		ELV-ELV Dimming (1%)		IG-In Ground		2X96-2X96 Watts		24-24 VDC

MODELS	2X96W
Length	8.40"
Width	8.30"
Depth	8.10"

PS120-ELV-IG-2X96-24



LUTRON®

Luminii is a Lutron OEM Advantage Partner

Lutron Power Supplies 1%

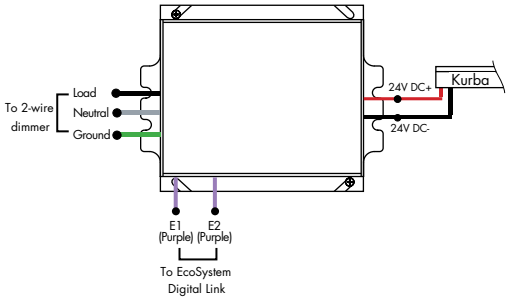
MODEL

L3DA4U1UKL-CV240

HiLume™ 1% EcoSystem Voltage LED driver
40W max

MODELS	L3DA4U1UKL-CV240
Length	4.98"
Width	4.00"
Depth	2.62"

L3DA4U1UKL-CV240



LUTRON®

Luminii is a Lutron OEM Advantage Partner

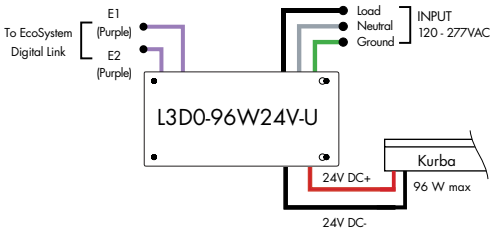
Lutron Power Supplies 0.1%

MODEL

L3D0-96W24V-U

HiLume™ 0.1% EcoSystem Voltage LED Driver with Soft-On, Fade-to-Black™
96W max

MODELS	L3D0
Length	10.50"
Width	5.50"
Depth	2.00"



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UVA-20011

Vancouver 2 Light Column

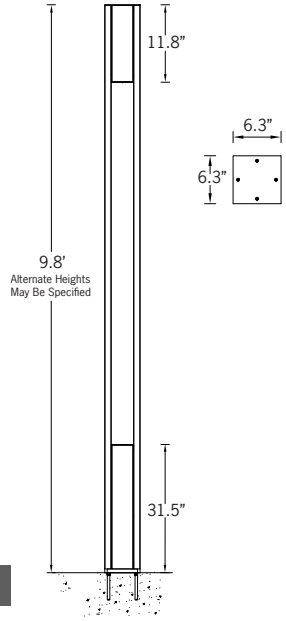
LIGMAN LIGHTING USA

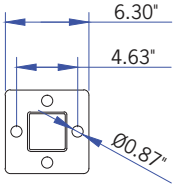
20w COB
1414 Lumens

IP65
Suitable for wet locations

IK08
Impact Resistant [Vandal Resistant]

Weight 55.1 lbs





Mounting Detail

Construction

Aluminum
Less than 0.1% copper content – Marine Grade 6060 extruded & LM6 Aluminum High Pressure die casting provides excellent mechanical strength , clean detailed product lines and excellent heat dissipation.

Pre paint
8 step degrease and phosphate process that includes deoxidizing and etching as well as a zinc and nickel phosphate process before product painting.

Memory Retentive -Silicon Gasket
Provided with special injection molded "fit for purpose" long life high temperature memory retentive silicon gaskets. Maintains the gaskets exact profile and seal over years of use and compression.

Thermal management
LM6 Aluminum is used for its excellent mechanical strength and thermal dissipation properties in low and high ambient temperatures. The superior thermal heat sink design by Ligman used in conjunction with the driver, controls thermals below critical temperature range to ensure maximum luminous flux output, as well as providing long LED service life and ensuring less than 10% lumen depreciation at 50,000 hours.

Surge Suppression
Standard 10kv surge suppressor provided with all fixtures.

BUG Rating
B1 - U0 - G0

Finishing
All Ligman products go through an extensive finishing process that includes fettling to improve paint adherence.

Paint
UV Stabilized 4.9Mil thick powder coat paint and baked at 200˚ C. This process ensures that Ligman products can withstand harsh environments. Rated for use in natatoriums.

Inspired by Nature Finishes
The Inspired by nature Finishing is a unique system of decorative powder coating. Our metal decoration process can easily transform the appearance of metal or aluminum product into a wood grain finish.

This patented technology enables the simulation of wood grain, and even marble or granite finish through the use of decorative powder coating.

The wood grain finish is so realistic that it's almost undistinguishable from real wood, even from a close visual inspection. The system of coating permeates the entire thickness of the coat and as a result, the coating cannot be removed by normal rubbing, chipping, or scratching.

The Coating Process
After pre-treatment the prepared parts are powder coated with a specially formulated polyurethane powder. This powder provides protection against wear, abrasion, impact and corrosion and acts as the relief base color for the finalized metal decoration.

The component is then wrapped with a sheet of non-porous film with the selected decoration pattern printed on it using special high temperature inks.

This printed film transfer is vacuum-sealed to the surface for a complete thermo print and then transferred into a customized oven. The oven transforms the ink into different forms within the paint layer before it becomes solid. Finally, the film is removed, and a vivid timber look on aluminum remains.

Wood grain coating can create beautiful wood-looking products of any sort. There are over 300 combinations of designs currently in use. Wood grains can be made with different colors, designs, etc.

Our powder coatings are certified for indoor and outdoor applications and are backed by a comprehensive warranty. These coatings rise to the highest conceivable standard of performance excellence and design innovation.

Added Benefits
- Resistance to salt-acid room, accelerated aging
- Boiling water, lime and condensed water resistant
- Anti-Graffiti, Anti-Slip, Anti-Microbial, Anti-Scratch
- Super durable (UV resistant)
- TGIC free (non-toxic)

Hardware
Provided Hardware is Marine grade 316 Stainless steel.

Anti Seize Screw Holes
Tapped holes are infused with a special anti seize compound designed to prevent seizure of threaded connections, due to electrolysis from heat, corrosive atmospheres and moisture.

Crystal Clear Low Iron Glass Lens
Provided with tempered, impact resistant crystal clear low iron glass ensuring no green glass tinge.

Optics & LED
Precise optic design provides exceptional light control and precise distribution of light.
LED CRI > 80

Lumen - Maintenance Life
L80 /B10 at 50,000 hours (This means that at least 90% of the LED still achieve 80% of their original flux)

Total urban realm lighting solution.
Optional heights, accent spotlights, accessories and decorative lattice panels.

A stylish Dark Sky Compliant square high performance light column with downward light distribution using LED lamps. This light column offers optimal visual comfort through glare control by utilizing a controlled optics designed by Ligman. These columns have a square design providing a unique wide light distribution, offering an architecturally appealing clover leaf pattern on the paving. The internal sides of the supporting pillars are accented by light from the LED.

Color temperature 2700K, 3000K, 3500K and 4000K. The minimalistic shape provides distinctive lighting effects by night and decorative urban effect during the day. Suitable for pedestrian areas, precincts, building surrounds, shopping centers, squares and parks. The Vancouver Column comes standard with a unique waterproof internal driver housing compartment that is situated at the top of the pole to stop water and dust from entering the electrical components.

This fixture is supplied completely wired with powercord and waterproof gland from the driver enclosure to the base of the column to ensure quick trouble-free installation. The Vancouver has a specially designed anchor bolt mounting base that is partially buried below ground level to provide a flush fixture finish with the surface, but maintains the rigidity that is required when installing light columns. This ensures that the anchor bolts are not seen and therefore eliminates the necessity for an anchor bolt cover. (review installation instructions before installing the anchor bolts.)

Custom column heights are available, please specify. Provided with anchor bolts (the root mount kit is an option and is an adder)

Reduced custom wattages can be provided to suit customer requirements. (Specify total watt requirement per fixture) Designed to complement the Vancouver bollard UVA-10001. This product is provided complete with anchor bolts and laser cut steel bolt template.

To meet International Dark Sky criteria, 3000k or warmer LEDs must be selected.

• NOTE: For the round version of the Vancouver, please see the Benton Light Column and Bollard

Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements in LED technology data and components may change without notice.

UVA-20011

Vancouver 2 Light Column

LIGMAN LIGHTING USA

PROJECT		DATE	

QUANTITY		TYPE		NOTE	

ORDERING EXAMPLE || UVA - 20011 - 20w - W30 - 02 - 120/277v - Options

UVA-20011				
	LAMP	LED COLOR	FINISH COLOR	VOLTAGE
	20w COB 1414 Lumens	W27 - 2700K W30 - 3000K W35 - 3500K W40 - 4000K	01 - BLACK RAL 9011 02 - DARK GREY RAL 7043 03 - WHITE RAL 9003 04 - METALLIC SILVER RAL 9006 05 - MATTE SILVER RAL 9006 06 - LIGMAN BRONZE 07 - CUSTOM RAL	120/277v Other - Specify

INSPIRED BY NATURE FINISHES

SW01 - OAK FINISH
SW02 - WALNUT FINISH
SW03- PINE FINISH
DF - DOUGLAS FIR FINISH
CW - CHERRY WOOD FINISH
NW - NATIONAL WALNUT FINISH
SU01 - CONCRETE FINISH
SU02 - SOFTSCAPE FINISH
SU03 - STONE FINISH
SU04 - CORTEN FINISH

THERE IS AN ADDITIONAL COST FOR THESE FINISHES

ADDITIONAL OPTIONS

NAT - Natatorium Rated
DIM - 0-10v Dimming
HGT - Custom Height (Specify)
GFCI - GFCI Box
UP - Uplight

DICHROIC COLOR FILTERS

RD - Red Color Filter
BL - Blue Color Filter
AM - Amber Color Filter
GR - Green Color Filter

Example: Two-Tone Inspired by Nature Finish

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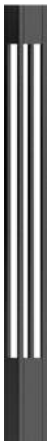
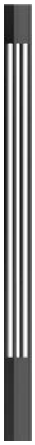
Intertek

Vancouver Product Family



Vancouver 1

- UVA-20001-40w-2969lm [9.4"x9.4"-14.7']



Vancouver 2

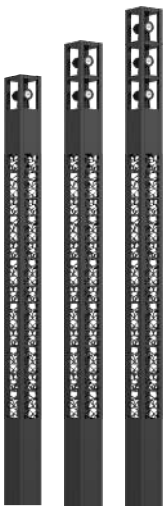
- UVA-20011-20w-1414lm [6.3"x6.3"-9.8']

Vancouver 3

- UVA-10001-21w-1270lm [9.4"x9.4"-39.3"]

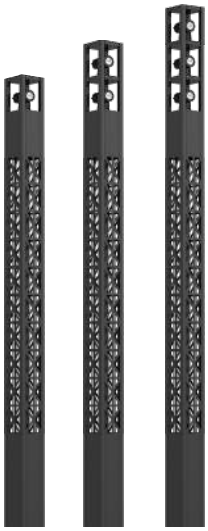
Vancouver 4

- UVA-10011-15w-837lm [6.3"x6.3"-39.3"]



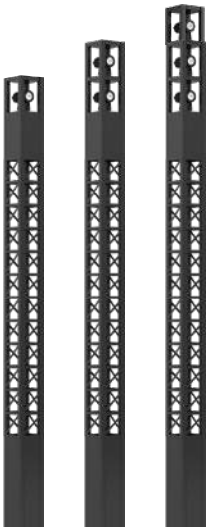
Vancouver 5

- UVA-20021-39/21w-1336/1673lm [9.4"x9.4"-13.3']
- UVA-20022-39/2x21w-1336/2x1673lm [9.4"x9.4"-14.5']
- UVA-20023-39/3x21w-1336/3x1673lm [9.4"x9.4"-15.7']



Vancouver 6

- UVA-20031-39/21w-1167/1673lm [9.4"x9.4"-13.3']
- UVA-20032-39/2x21w-1167/2x1673lm [9.4"x9.4"-14.5']
- UVA-20033-39/3x21w-1167/3x1673lm [9.4"x9.4"-15.7']



Vancouver 7

- UVA-20041-39/21w-1670/1673lm [9.4"x9.4"-13.3']
- UVA-20042-39/2x21w-1670/2x1673lm [9.4"x9.4"-14.5']
- UVA-20043-39/3x21w-1670/3x1673lm [9.4"x9.4"-15.7']

Vancouver 8

- UVA-20051-40w-1336lm [9.4"x9.4"-12.1']

Vancouver 9

- UVA-20061-40w-1167lm [9.4"x9.4"-12.1']

Vancouver 10

- UVA-20071-40w-1670lm [9.4"x9.4"-12.1']

Vancouver 11

- UVA-10021-21w-570lm [9.4"x9.4"-39.3']

Vancouver 12

- UVA-10031-21w-490lm [9.4"x9.4"-39.3']

Vancouver 13

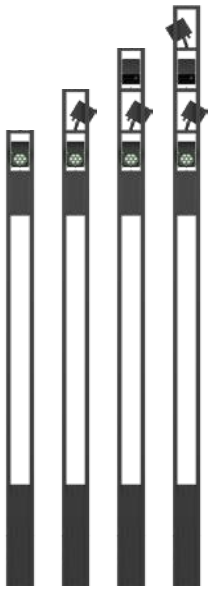
- UVA-10041-21w-704lm [9.4"x9.4"-39.3']

Vancouver 14

- UVA-70001-8w-331lm [6.3"x6.3"-15.7"]

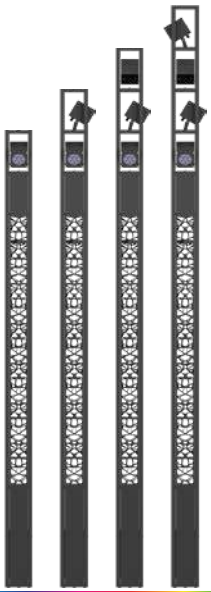
Vancouver 15

- UVA-70011-21w-815lm [9.4"x9.4"-15.7"]



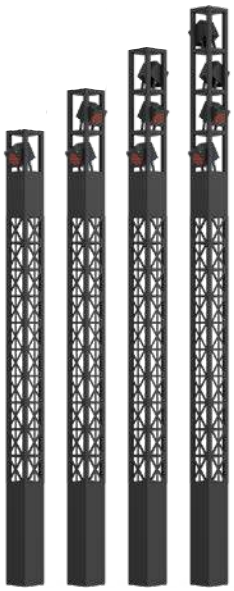
Vancouver 16

- UVA-20111-33w-1429lm [9.4"x9.4"-13.3']
- UVA-20112-66w-4287lm [9.4"x9.4"-14.5']
- UVA-20113-99w-5716lm [9.4"x9.4"-15.7']
- UVA-20114-132w-7145lm [9.4"x9.4"-17']



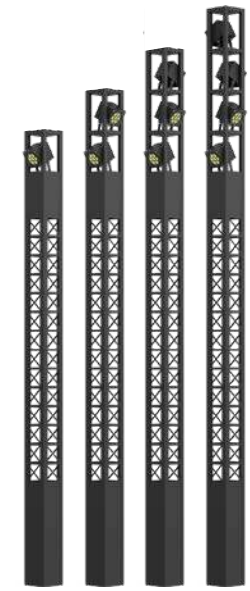
Vancouver 17

- UVA-20121-33w-2858 lm [9.4"x9.4"-13.3']
- UVA-20122-66w-4287lm [9.4"x9.4"-14.5']
- UVA-20123-99w-5716lm [9.4"x9.4"-15.7']
- UVA-20124-132w-7145lm [9.4"x9.4"-17']



Vancouver 18

- UVA-20131-33w-2858lm [9.4"x9.4"-13.3']
- UVA-201312-66w-4287lm [9.4"x9.4"-14.5']
- UVA-20133-99w-5716lm [9.4"x9.4"-15.7']
- UVA-20134-132w-7145lm [9.4"x9.4"-17']



Vancouver 19

- UVA-20141-33w-2858lm [9.4"x9.4"-13.3']
- UVA-20142-66w-4287lm [9.4"x9.4"-14.5']
- UVA-20143-99w-5716lm [9.4"x9.4"-15.7']
- UVA-20144-132w-7145lm [9.4"x9.4"-17']

Vancouver 20

- UVA-20151-33w-1429lm [9.4"x9.4"-12.1']

Vancouver 21

- UVA-20161-33w-1429lm [9.4"x9.4"-12.1']

Vancouver 22

- UVA-20171-33w-1429lm [9.4"x9.4"-12.1']

Vancouver 23

- UVA-20181-33w-1429lm [9.4"x9.4"-12.1']

Vancouver 24

- UVA-30001-8w-331lm [6.3"x6.3"-15.7"]

Vancouver 25

- UVA-30011-21w-570lm [6.3"x6.3"-23.6"]

Vancouver 26

- UVA-30012-21w-490lm [6.3"x6.3"-23.6"]

Vancouver 27

- UVA-30013-21w-740lm [6.3"x6.3"-23.6"]

Vancouver 28

- UVA-30021-39w-1336lm [9.4"x9.4"-39.3"]
- UVA-30031-33w RGBW-429lm [9.4"x9.4"-39.3"]

Vancouver 29

- UVA-30022-39w-1167lm [9.4"x9.4"-39.3"]
- UVA-30032-33w RGBW-1158lm [9.4"x9.4"-39.3"]

Vancouver 30

- UVA-30023-39w-1670lm [9.4"x9.4"-39.3"]
- UVA-30033-33w RGBW-439lm [9.4"x9.4"-39.3"]

Vancouver 31

• UVA-10101-7w-200lm [4.7" x 4.7" - 23.6"]

Vancouver 33

• UVA-10051-15w-1083lm [6.3" x 6.3" - 39.3"]

Vancouver 34

• UVA-10061-21w-1571lm [9.4" x 9.4" - 39.3"]

Vancouver 35

• UVA-10071-21w-1571lm [9.4" x 9.4" - 39.3"]

Vancouver 36

• UVA-10072-21w-1571lm [9.4" x 9.4" - 39.3"]

Vancouver 37

• UVA-10073-21w-1571lm [9.4" x 9.4" - 39.3"]

Vancouver 38

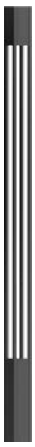
• UVA-10141-8w-95lm [4.7" x 4.7" - 23.6"]

Vancouver 39

• UVA-10151-15w-418lm [6.3" x 6.3" - 39.3"]

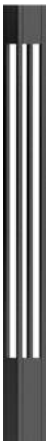
Vancouver 40

• UVA-10161-21w-635lm [9.4" x 9.4" - 39.3"]



Vancouver 41

• UVA-20191-20w-1326lm [6.3" x 6.3" - 9.8']



Vancouver 42

• UVA-20201-40w-2969 lm [9.4" x 9.4" - 14.7']

Vancouver 43

• UVA-20211-39/21w-2781/1688lm [9.4"x9.4"-13.3']

Vancouver 44

• UVA-20212-39/2x21w-2781/2x1688lm [9.4"x9.4"-14.5']

Vancouver 45

• UVA-20213-39/3x21w-2781/3x1688lm [9.4"x9.4"-15.7']

Vancouver 46

• UVA-20221-39/21w-4469/1688lm [9.4"x9.4"-13.3']

Vancouver 47

• UVA-20221-39/2x21w-4469/2x1688lm [9.4"x9.4"-14.5']

Vancouver 48

• UVA-20223-39/3x21w-4469/3x1688lm [9.4"x9.4"-15.7']

Vancouver 49

• UVA-20231-39/21w-2781/1688lm [9.4"x9.4"-13.3']

Vancouver 50

• UVA-20232-39/2x21w-2781/2x1688lm [9.4"x9.4"-14.5']

Vancouver 51

• UVA-20233-39/2x21w-2781/2x1688lm [9.4"x9.4"-15.7']

Vancouver 52

• UVA-20241-40w-2781lm [9.4"x9.4"-12']

Vancouver 53

• UVA-20242-40w-2781lm [9.4"x9.4"-12']

Vancouver 54

• UVA-20243-40w-2781lm [9.4"x9.4"-12']

Vancouver 55

• UVA-20251-21w-710lm [6.3"x6.3"-9.8']

Vancouver 56

• UVA-20261-40w-1485lm [9.4"x9.4"-14.7']

Vancouver 60

• UVA-20281-76w-4140lm [9.4"x9.4"-12']

Vancouver 61

• UVA-20282-76w-4140lm [9.4"x9.4"-12']

Vancouver 62

• UVA-20283-76w-4140lm [9.4"x9.4"-12']

Vancouver 63

• UVA-70021-13w-437lm [6.3"x6.3"-15.7']

Vancouver 64

• UVA-70031-20w-1362lm [9.4"x9.4"-15.7']

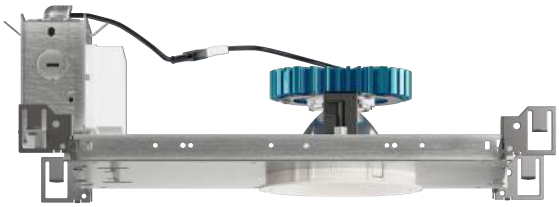
alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

NU4

4" Round Downlight Standard White

NSF AT airtight DF dead-front PR plenum rated wet rated



Trim

Trimless

Trimless Millwork

20° - 65° BEAM (Note: Specifications are subject to change without notice)		
14mm COB PERFORMANCE DATA		
LED LIGHT ENGINE	NOMINAL DELIVERED LUMENS	SYSTEM WATTAGE
10LM	990LM @30K/80CRI	9W
15LM	1485LM @30K/80CRI	12W
20LM	2095LM @30K/80CRI	17W
25LM	2540LM @30K/80CRI	21W
30LM	3090LM @30K/80CRI	26W
35LM	3580LM @30K/80CRI	31W
40LM	4180LM @30K/80CRI	37W
10LM	840LM @30K/90/CRI	9W
15LM	1260LM @30K/90/CRI	12W
20LM	1780LM @30K/90/CRI	17W
25LM	2160LM @30K/90/CRI	21W
30LM	2620LM @30K/90/CRI	26W
35LM	3040LM @30K/90/CRI	31W
40LM	3550LM @30K/90/CRI	37W
Notes	Delivered lumens based on 25D optic with no lens, (see page 2)	

12° BEAM (Note: Specifications are subject to change without notice)		
10mm COB PERFORMANCE DATA		
LED LIGHT ENGINE	NOMINAL DELIVERED LUMENS	SYSTEM WATTAGE
10LM	810LM @30K/80CRI	9W
15LM	1580LM @30K/80CRI	17W
20LM	2010LM @30K/80CRI	23W
10LM	690LM @30K/90CRI	9W
15LM	1340LM @30K/90CRI	17W
20LM	1710LM @30K/90CRI	23W
Notes	Delivered lumens based on 12D optic no lens, (see page 2)	

8° BEAM (Note: Specifications are subject to change without notice)		
6mm COB PERFORMANCE DATA		
LED LIGHT ENGINE	NOMINAL DELIVERED LUMENS	SYSTEM WATTAGE
10LM	790LM @30K/80CRI	12W
15LM	1250LM @30K/80CRI	20W
10LM	670LM @30K/90CRI	12W
15LM	1060LM @30K/90CRI	20W
Notes	Delivered lumens based on 8D optic no lens, (see page 2)	

FEATURES

- 3/4" bezel regress with 1/16" micro flange
- 8° - 65° optical beam control
- UGR < 19
- Up to 110 LPW
- Glare control, specialty optics, trim options, and custom finishes available
- Microban® antimicrobial finish available on all exposed painted surfaces

DIMMING AND CONTROLS

- eldoLED flicker free 0-10V dimming to 0% and 1%
- eldoLED flicker free DALI dimming to 0% and 1%
- DMX dim to zero
- Lutron Hi-lume 1% 3-wire/Ecosystem
- Lutron athena wireless node
- Leading & trailing edge (Triac/ELV) dimming to 1%
- Casambi dimming to 1.0%
- NLight control interface dimming to 0%

CONSTRUCTION

- Lexan™ (PC) highly resistant to impact and heat (240°F)
- Optimal material for wireless signal connectivity
- Shatter proof acrylic bezel lens
- Electrocoated 16-gauge cold-rolled steel construction
- Accommodates ceiling thickness from 1/8" to 1-3/4"

LED

- 90 CRI: SDCM = 2-step MacAdam Ellipse, Lumen Maintenance: L_{70} > 66,000 hrs
- 80 CRI: SDCM = 2-step MacAdam Ellipse, Lumen Maintenance: L_{70} > 66,000 hrs

LISTING

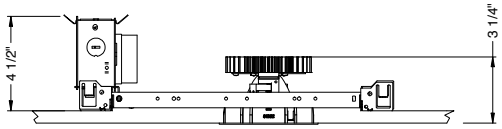
- ULus Listed to UL1598 & UL2108; cUL Listed to CSA C22.2 #250.0
- IP65 with lens - Suitable for wet locations with lens - Suitable for damp locations without lens
- Non-conductive, dead-front construction (shower approved)
- NSF/ANSI-2 with lens (Non-Food and Splash Zones)
- **Declare.** - LBC Red List Approved
- 5 Year Limited warranty

ELECTRICAL

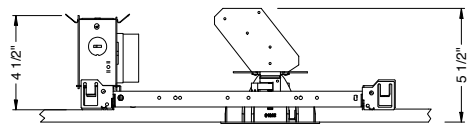
- 120V-277V, 120 only Triac / ELV
- Power factor ≥ 0.9
- 2kV driver input surge protection
- Remote and Integral (ITS) emergency test switch
- 7W, 10W (T20 CEC) and 12W EM 90min battery
- Max. ambient installation temperature 95°F (35°C)
- Low Voltage Luminaire option, see page 11.

FIXTURE HEIGHT

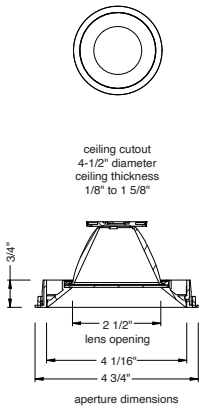
10LM - 30LM LOW LUMENS



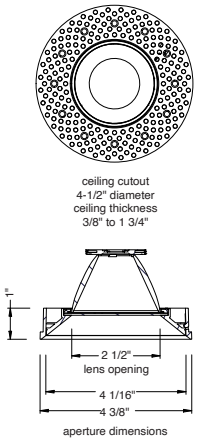
35LM - 40LM HIGH LUMENS



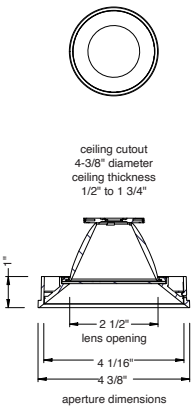
TRIMMED



TRIMLESS



MILLWORK



Alphabet by Ledra Brands, Inc. | 88 Maxwell Irvine, CA 92618 | **PH:** 714.259.9959 **FAX:** 714.259.9969 | AlphabetLighting.com

101118

In a continuing effort to offer the best product possible we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product.

alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

8°- 65° BEAM ORDERING CODE

SERIES	NU4	NU4
TYPE	RD	round downlight
	RDT	round downlight trimless
	RDTMW	round downlight trimless millwork
LED	SW	standard white
DELIVERED LUMENS	10LM	990 lm
	15LM	1485 lm
	20LM	2095 lm
	25LM	2540 lm
	30LM	3090 lm
	35LM	3580 lm
	40LM	4180 lm

Standard Configuration: 3000K 80CRI 25D, **NL**

Calculated Delivered Lumens = [Delivered Lumen Value] x [CCT Multiplier] x [Reflector Multiplier]

CCT	27K	2700K
	30K	3000K
	35K	3500K
	40K	4000K

CCT	2700K		3000K		3500K		4000K	
CRI	80+	90+	80+	90+	80+	90+	80+	90+
CCT MULTIPLIER FOR LUMEN OUTPUT	0.96	0.81	1.00	0.85	1.03	0.88	1.06	0.91

CRI	80	80 CRI	
	90	90 CRI	
OPTIC & LM MULTIPLIER SEE PAGE 5, 6	8D[1]	8 degrees	(1.00)
	12D[1]	12 degrees	(1.00)
	20D	20 degrees	(0.99)
	25D	25 degrees	(1.00)
	35D	35 degrees	(0.99)
	50D	50 degrees	(0.99)
	65D	65 degrees	(0.99)
BEZEL LENS SEE PAGE 3	NL[2]	no lens	(1.00)
	CL	clear lens	(0.98)
	DL	diffused lens	(0.91)
	E[3]	elliptical beam spread	(0.92)
	HCL[4]	honeycomb louver	(0.85)
	HET	high efficiency textured lens, similar to Solite™	(0.92)
	SBL	smoothing beam lens	(0.92)

Color lenses (amber, blue, green, red) see page 4.

TRIM COLOR SEE PAGE 3	BK	black
	WH	white
	MC	matte chrome
	BZ	bronze
	WT	wheat
	CC[5]	custom color, consult factory for details

Antimicrobial finish, add **AM** to black, white or matte chrome i.e. BKAM.

Not applicable to trimless option. Do not include in trimless ordering code.

BEZEL COLOR SEE PAGE 3	BK	black	(0.98)
	WH	white	(1.00)
	MC	matte chrome	(0.99)
	BZ	bronze	(0.98)
	WT	wheat	(0.99)
	CC[5]	custom color, consult factory for details	

Antimicrobial finish, add **AM** to black, white or matte chrome i.e. BKAM.

8°- 65° BEAM ORDERING CODE

MOUNTING OPTIONS SEE PAGE 8, 9	NC	new construction with ceiling fitting plate
	IC[6]	insulation contact housing
	ICAT[6]	insulation contact/airtight housing
	CP[6]	chicago plenum housing
	RET	retrofit, no ceiling fitting plate
VOLTAGE	120	120V
	UNV	120V-277V
	LVL[7]	low voltage luminaire
DIMMING	DIM10	eldoLED flicker free 0-10V dimming to 1%
	DIM10Z	eldoLED flicker free 0-10V dimming to 0%
	DALI	eldoLED flicker free DALI-2 dimming to 1%
	DALIZ	eldoLED flicker free DALI-2 dimming to 0%
	DMX-RJ45	DMX control dimming to 0.1% with RJ45 connection
	DMX-WL	DMX control dimming to 0.1% with wire lead connection
	DMX-XLR	DMX control dimming to 0.1% with XLR 5pin connection
	LUT	Lutron Hi-lume Ecosystem dimming to 1%, Soft-on & Fade-to-Black
	LUTP[8]	Lutron Hi-lume Premier Ecosystem dimming to 0.1%, Soft-on & Fade-to-Black
	ELV1[9]	leading & trailing edge (Triac/ELV) dimming to 1%
	NLT	nLight control interface: standard Cat-5/RJ45 connection (female), dim to off
	CAS	Casambi control with flicker free 1% dimming
	AWNR[10]	lutron athena wireless node
	L3DA	Lutron Hi-lume 1% 3-wire/Ecosystem
	ND	No Driver Included. Customer to Supply PoE system components or order remote driver separately. Refer to POE/Remote Driver reference sheet for additional details.
ELECTRICAL OPTIONS	EM7[11]	emergency battery backup, 90 minutes at 7W to LED
	EM12[11]	emergency battery backup, 90 minutes at 12W to LED
	EM10CA20[11]	remote emergency battery backup, 90 minutes at 10W to LED, CA title 20

ADDITIONAL MOUNTING INFO

New Construction Bar Hangers (included)	Mounting Length: 14-3/4" to 26"
Extension Kit p/n: K20266 (ordered separately, 1 per fixture)	*Extends a pair of Bar Hangers* Total Mounting Length: 29" to 48"

YOUR COMPLETED ORDERING CODE

Follow the steps to specify your fixture, example:

NU4 - RD - SW - 20LM - 35K - 90 - 8D - NL - WH - WH - NC - UNV - DIM10 - EM7

NOTES

1. 8D/12D available in 10LM/15LM.
2. NL option does not meet requirements for AT/DF/WET/NSF listings. Lensing cannot be added in the field.
3. Elliptical lens not available with 8D/12D optic options. Actual beam distributions [20D= 35° x 60° , 25D= 40° x 65° , 35D= 45° x 70° , 55D= 55° x 80°]
4. HCL not available with lens.
5. Custom set up fee plus minimum quantity required per color.
6. IC/ICAT/CP not available in 40LM.
7. Must select ND dimming code, for remote driver or POE specifications see page 11.
8. LUTP not available in 25LM/30LM/40LM.
9. ELV1 (120V) not available in 10LM.
10. AWNR reference page 11 for product specifications on Athena wireless node.
11. For integrated test switch add "ITS" after emergency backup code, i.e. EM12ITS. Test switch is mounted in the bezel of the fixture.

* EldoLED and DMX uses logarithmic dimming curve as standard. For linear dimming curve, add "LIN" after dimming code, i.e. DIM10LIN.

alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

TRIM OPTIONS

TRIM/BEZEL COLORS

WH

MC

BK

BZ

WT

OPTICAL OPTIONS

- UGR calculation based on CIE 117-1995; room size: 4H X 8H, reflectance: 70/50/20;
- UGR calculation based on 15LM fixtures, unless otherwise noted.

REFLECTOR OPTIC ACCESSORY
Honeycomb Louver

OPTIC	BEAM ANGLE	UGR
8D	7.8	10.9
12D	11.3	23.5
20D	17.4	12.5
25D	22.2	13.9
35D	32.4	16.5
50D	44.9	13.4
65D	52	15.5

NL
No Lens

OPTIC	BEAM ANGLE	UGR
8D	7.8	14.2
12D	11.9	13.8
20D	18	13.6
25D	22.8	13.1
35D	36.2	14.5
50D	49.2	18.3
65D	64.5	18.8

CL
Clear Lens

OPTIC	BEAM ANGLE	UGR
8D	7.9	13.7
12D	12.1	13.3
20D	18	13.3
25D	22.8	12.8
35D	36.2	14.2
50D	49.2	18.1
65D	64.6	18.5

DL
Diffused Lens

OPTIC	BEAM ANGLE	UGR
20D	39.4	19.5
25D	42.4	19.8
35D	50.6	20.8
50D	56.7	21.4
65D	66.7	23.3

HET
High Efficiency Textured Lens

OPTIC	BEAM ANGLE	UGR
20D	22.5	13.8
25D	27	14
35D	38.8	15.8
50D	49.8	16.5
65D	60.4	19.5

SBL
Smoothing Beam Lens

OPTIC	BEAM ANGLE	UGR
8D	10.2	12.8
12D	13.2	12.9
20D	19.3	13
25D	24.3	13.1
35D	37.2	14.8
50D	51.2	15.6
65D	62.2	18.8

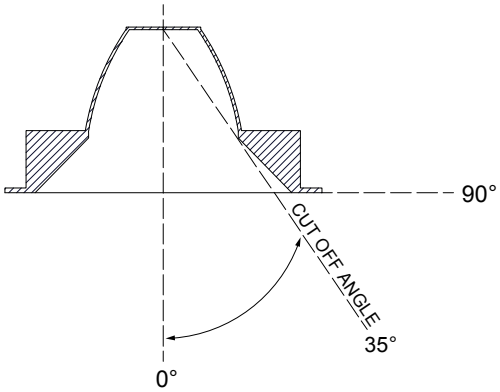
GLARE CONTROL

CUT-OFF ANGLE

Visual comfort is achieved with a lower cut-off angle due to improved glare control. The smaller the cut-off angle, the easier it is on the eye.

Alphabet downlights have been thoughtfully engineered to eliminate glare while still delivering functional illumination.

- Cutoff angle of CL is 35 degrees;



alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

TRIM OPTIONS

TRIM/BEZEL COLORS

WH

MC

BK

BZ

WT

OPTICAL OPTIONS

- UGR calculation based on CIE 117-1995; room size: 4H X 8H, reflectance: 70/50/20;
- UGR calculation based on 15LM fixtures, unless otherwise noted.

AMBER

OPTIC	MULTIPLIER	BEAM SPREAD
20D	0.485	18°
25D	0.484	22°
35D	0.485	35°
50D	0.48	50°
65D	0.473	60°

AVERAGE LUMENS:2000LM 1880 CCT

RED

OPTIC	MULTIPLIER	BEAM SPREAD
20D	0.04	18°
25D	0.04	22°
35D	0.04	35°
50D	0.04	50°
65D	0.038	60°

AVERAGE LUMENS: 168LM

GREEN

OPTIC	MULTIPLIER	BEAM SPREAD
20D	0.202	18°
25D	0.202	22°
35D	0.204	35°
50D	0.2	50°
65D	0.196	60°

AVERAGE LUMENS: 850LM

BLUE

OPTIC	MULTIPLIER	BEAM SPREAD
20D	0.051	18°
25D	0.051	22°
35D	0.053	35°
50D	0.05	50°
65D	0.049	60°

AVERAGE LUMENS: 210LM

Add AM / BL / GR / RD to bezel lens ordering code section.
Example: NU4 - RD - SW - 10LM - 30K - 80 - 35D - **BL** - WH - WH - NC - UNV - DIM

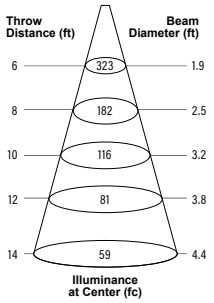
alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

PHOTOMETRIC DATA

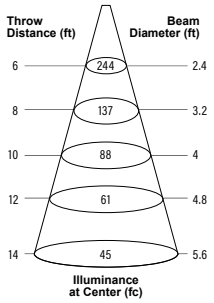
20LM CCT MULTIPLIERS		
	80CRI	90CRI
2700K	0.96	0.81
3000K	1	0.85
3500K	1.03	0.88
4000K	1.06	0.91
FC Formula = CBCP / Distance^2		

20D 18° NO LENS



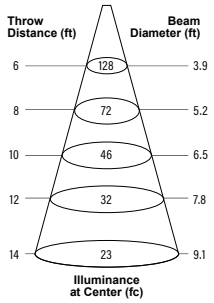
WATTS: 17.2	LPW: 121.4
LUMENS: 2088	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	11622
5	10517
15	2170
25	862
35	401
45	3

25D 23° NO LENS



WATTS: 17.2	LPW: 122.1
LUMENS: 2099	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	8779
5	7589
15	2759
25	940
35	372
45	2

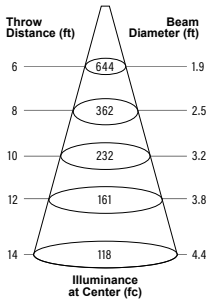
35D 36° NO LENS



WATTS: 17.2	LPW: 120.6
LUMENS: 2074	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	4594
5	4283
15	2845
25	1317
35	435
45	10

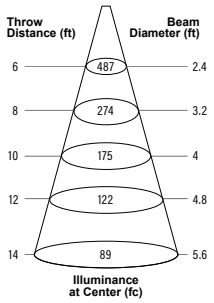
40LM CCT MULTIPLIERS		
	80CRI	90CRI
2700K	0.96	0.81
3000K	1	0.85
3500K	1.03	0.88
4000K	1.06	0.91
FC Formula = CBCP / Distance^2		

20D 18° NO LENS



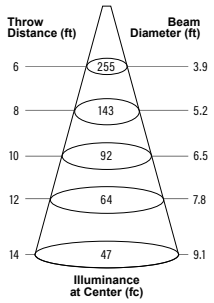
WATTS: 37.3	LPW: 111.7
LUMENS: 4165	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	23188
5	20984
15	4329
25	1719
35	799
45	5

25D 23° NO LENS



WATTS: 37.3	LPW: 112.3
LUMENS: 4189	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	17516
5	15142
15	5504
25	1876
35	742
45	4

35D 36° NO LENS



WATTS: 37.3	LPW: 110.9
LUMENS: 4138	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	9166
5	8545
15	5676
25	2627
35	868
45	19

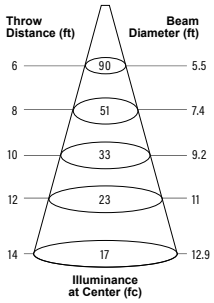
alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

PHOTOMETRIC DATA

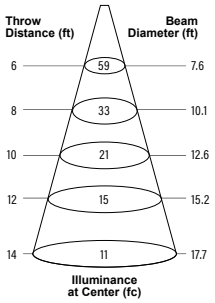
20LM CCT MULTIPLIERS		
	80CRI	90CRI
2700K	0.96	0.81
3000K	1	0.85
3500K	1.03	0.88
4000K	1.06	0.91
FC Formula = CBCP / Distance^2		

50D 49° NO LENS



WATTS: 17.2	LPW: 121.2
LUMENS: 2085	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	3253
5	3231
15	2606
25	1591
35	450
45	13

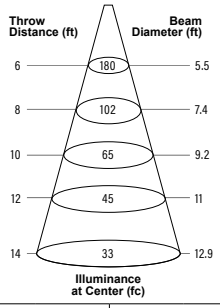
65D 65° NO LENS



WATTS: 17.2	LPW: 120.9
LUMENS: 2080	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	2103
5	2101
15	1990
25	1520
35	779
45	144

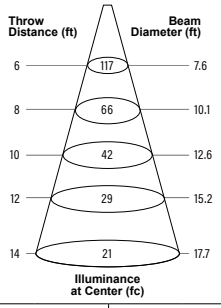
40LM CCT MULTIPLIERS		
	80CRI	90CRI
2700K	0.96	0.81
3000K	1	0.85
3500K	1.03	0.88
4000K	1.06	0.91
FC Formula = CBCP / Distance^2		

50D 49° NO LENS



WATTS: 37.3	LPW: 111.5
LUMENS: 4160	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	6491
5	6446
15	5200
25	3175
35	898
45	25

65D 65° NO LENS



WATTS: 37.3	LPW: 111.2
LUMENS: 4150	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	4195
5	4191
15	3971
25	3033
35	1555
45	288

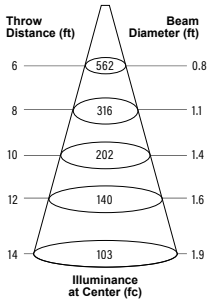
alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

PHOTOMETRIC DATA

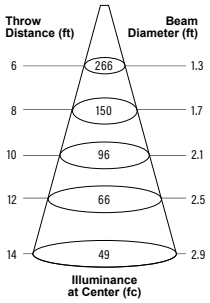
10LM CCT MULTIPLIERS		
	80CRI	90CRI
2700K	0.96	0.81
3000K	1	0.85
3500K	1.03	0.88
4000K	1.06	0.91
FC Formula = CBCP / Distance^2		

8D 7.8° NO LENS



WATTS: 12	LPW: 66
LUMENS: 792	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	20223
5	6477
15	368
25	287
35	170
45	0

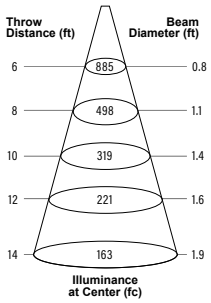
12D 12° NO LENS



WATTS: 8.7	LPW: 92.8
LUMENS: 807	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	9574
5	6065
15	532
25	299
35	155
45	0

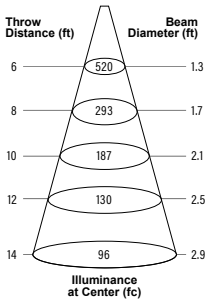
20LM CCT MULTIPLIERS		
	80CRI	90CRI
2700K	0.96	0.81
3000K	1	0.85
3500K	1.03	0.88
4000K	1.06	0.91
FC Formula = CBCP / Distance^2		

8D 7.8° NO LENS



WATTS: 20	LPW: 62.4
LUMENS: 1248	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	31866
5	10206
15	579
25	452
35	269
45	1

12D 12° NO LENS



WATTS: 17	LPW: 92.9
LUMENS: 1579	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	18725
5	11861
15	1041
25	585
35	303
45	0

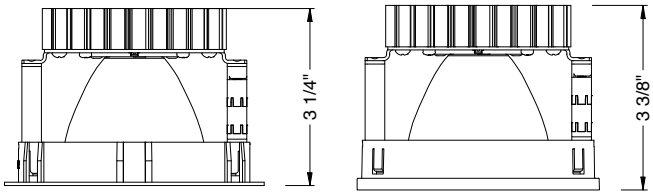
alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

MOUNTING OPTIONS

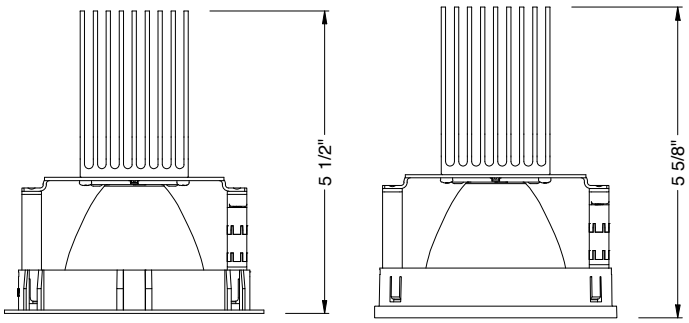
FIXTURE HEIGHT

10M - 30LM CONFIGURATION



TRIMMED TRIMLESS & MILLWORK

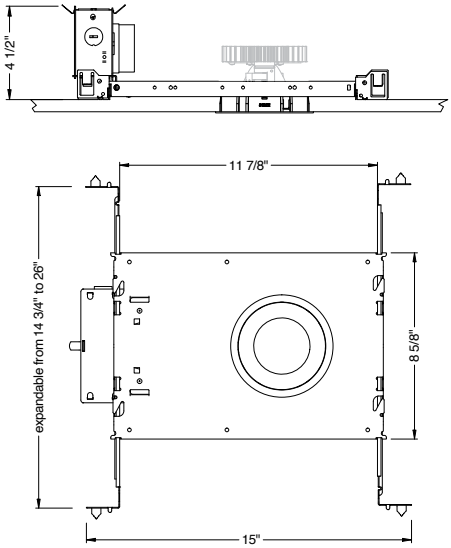
35M - 40LM CONFIGURATION



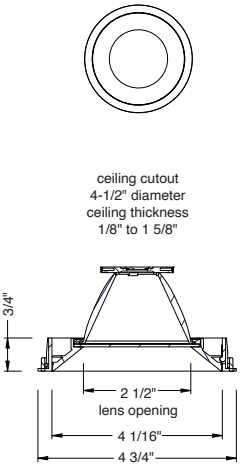
TRIMMED TRIMLESS & MILLWORK

NC - NEW CONSTRUCTION

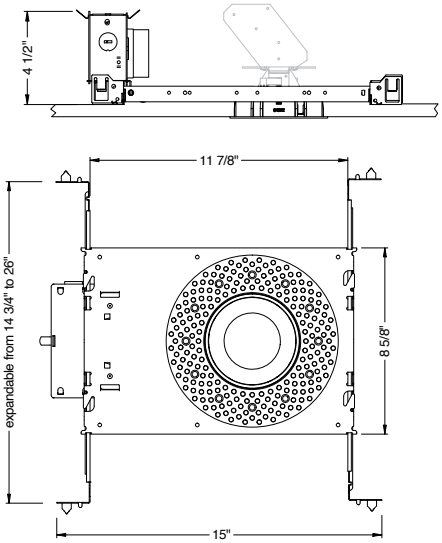
TRIM



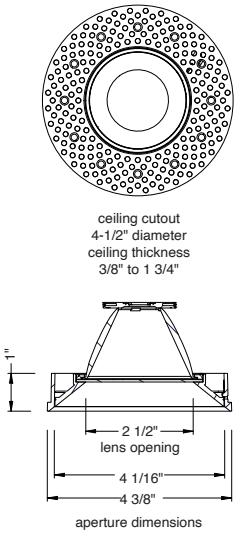
TRIM



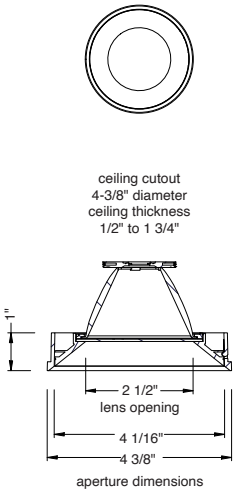
TRIMLESS



TRIMLESS



TRIMLESS/MILLWORK

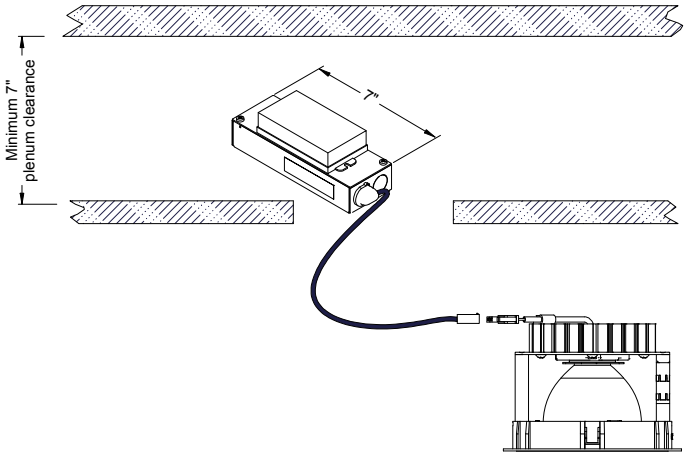


alphabet

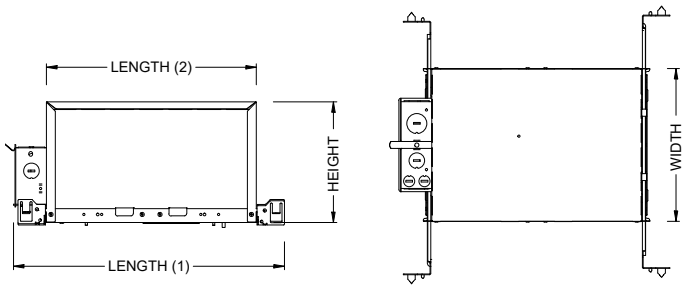
PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

MOUNTING OPTIONS (CONTINUED)

RET - RETRO
TRIM/TRIMLESS



IC - INSULATION CONTACT HOUSING
ICAT - INSULATION CONTACT / AIR TIGHT
CP - CHICAGO PLENUM



BOX SIZE	L 1	L 2	W	H
A	15 - 7/16"	11 - 3/4"	8 - 1/2"	6 - 3/4"
B	18 - 1/4"	14 - 7/8"	12 - 1/8"	11 - 1/4"

RATINGS / CERTIFICATIONS	NC	RET	IC	ICAT	CP
TYPE NON-IC	✔	✔			
TYPE IC			✔	✔	✔
CHICAGO PLENUM (CCEA)					✔
SUITABLE FOR AIR HANDLING PLENUMS	✔	✔	✔	✔	✔
REDUCED AIRFLOW (WITH LENS) ASTM E283	✔	✔	✔	✔	✔

CEILING THICKNESS	
FIXTURE TYPE	MOUNTING TYPE
	NC, IC, ICAT, CP, RET
	STANDARD CEILING THICKNESS
TRIM	1/8" to 1-5/8"
TRIMLESS	3/8" to 1-3/4"
MILLWORK (TRIMLESS)	1/2" to 1-3/4"

BOX TYPE / LUMEN OUTPUT - NARROW BEAM (8°-12°)						
LUMEN OUTPUT	BOX - A			BOX - B		
	IC	ICAT	CP	IC	ICAT	CP
10LM	✔	✔	✔			
15LM	✔	✔	✔			
20LM				✔	✔	✔

BOX TYPE / LUMEN OUTPUT - STANDARD BEAMS (20° - 65°)						
LUMEN OUTPUT	BOX - A			BOX - B		
	IC	ICAT	CP	IC	ICAT	CP
10LM	✔	✔	✔			
15LM	✔	✔	✔			
20LM	✔	✔	✔			
25LM	✔	✔	✔			
30LM	✔	✔	✔			
35LM				✔	✔	✔
40LM						

alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

BATTERY OPTIONS

EMERGENCY BATTERY

IOTA's ILB Battery Backups are UL Listed LED emergency drivers that allow the same LED fixture to be used for both normal and emergency operation. In the event of a power failure, the ILB switches to the emergency mode and operates the existing fixture for 90 minutes. The unit contains a battery, charger, and converter circuit in a single can. The Constant Power design of the ILB maintains the output wattage to the LED array even as the system voltage diminishes. UL 924 Listed for U.S. and Canada. UL 1310 Certified, Output Class 2 Compliant. Includes single-piece TBTS test switch and charge indicator accessory kit. For use with switched and unswitched fixtures, and includes Two-wire universal AC input. Meets or exceeds all National Electric Code and Life Safety Code Emergency Lighting Requirements. Rated for use in Plenum, Damp Location, Recessed Type IC, and Enclosed and Gasketed Luminares.

REMOTE TEST SWITCH

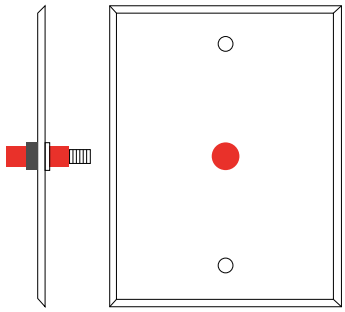
The Remote Test Switch may be mounted adjacent to the LED Fixture by others.

EMERGENCY BATTERY ACCESS

Above ceiling access is required for service. An access panel in the ceiling (or other form of access) adjacent to the installation location of the Emergency Battery is required.

REMOTE LOCATION

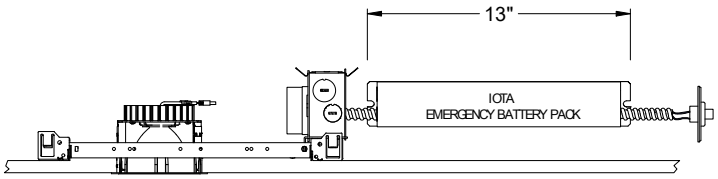
Maximum remote mounting distance of the emergency driver shall be 50 feet. Remote location wiring provided by others. Follow all Local and National Electric/ Building Codes.



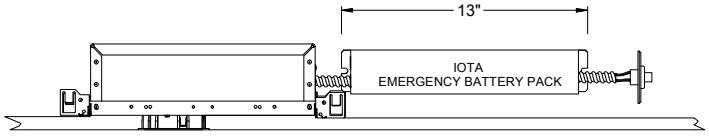
Remote Test Switch

EM MODE OUTPUT (DELIVERED LUMENS)			
LUMEN ORDERING CODE	EM7	EM10	EM12
ALL OPTIONS (10LM TO 30LM)	820LM	1200LM	1480LM
Notes: Based on 30K, 80CRI			

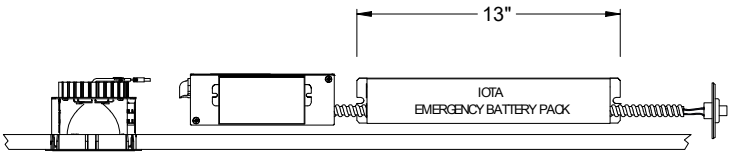
NC - NEW CONSTRUCTION
WITH EM BATTERY (REMOTE TEST SWITCH)



IC / ICAT / CP - INSULATION CONTACT HOUSING
WITH EM BATTERY (REMOTE TEST SWITCH)

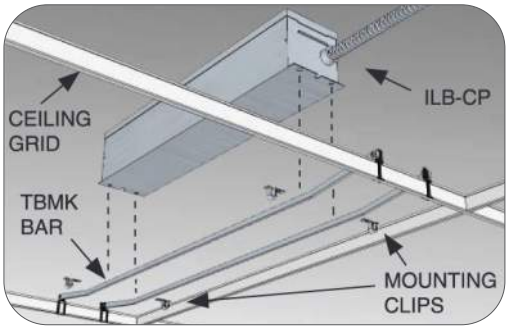


RET - RETROFIT
WITH EM BATTERY (REMOTE TEST SWITCH)



Accessory

76066 Optional T-Grid Mounting Kit[1]



1. Can be used with any of the Emergency Battery Backups. Must be ordered as a separate line item.

alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

LOW VOLTAGE OPTIONS

20° - 65° BEAM
(Note: Specifications are subject to change without notice)

14mm COB PERFORMANCE DATA

LED LIGHT ENGINE	NOMINAL DELIVERED LUMENS	DRIVE CURRENT	LED WATTAGE
10LM	990LM @30K/80CRI	250mA	9W
15LM	1485LM @30K/80CRI	300mA	11W
20LM	2095LM @30K/80CRI	425mA	15.5W
25LM	2540LM @30K/80CRI	525mA	19W
30LM	3090LM @30K/80CRI	650mA	23.5W
35LM	3580LM @30K/80CRI	800mA	29W
40LM	4180LM @30K/80CRI	900mA	32.5W
10LM	840LM @30K/90/CRI	250mA	9W
15LM	1260LM @30K/90/CRI	300mA	11W
20LM	1780LM @30K/90/CRI	425mA	15.5W
25LM	2160LM @30K/90/CRI	525mA	19W
30LM	2620LM @30K/90/CRI	650mA	23.5W
35LM	3040LM @30K/90/CRI	800mA	29W
40LM	3550LM @30K/90/CRI	900mA	32.5W
Notes	Delivered lumens based on 25D optic with no lens, (see page 2)		

12° BEAM
(Note: Specifications are subject to change without notice)

10mm COB PERFORMANCE DATA

LED LIGHT ENGINE	NOMINAL DELIVERED LUMENS	DRIVE CURRENT	LED WATTAGE
10LM	810LM @30K/80CRI	250mA	9W
15LM	1580LM @30K/80CRI	300mA	11W
20LM	2010LM @30K/80CRI	400mA	14.5W
10LM	690LM @30K/90CRI	250mA	9W
15LM	1340LM @30K/90CRI	300mA	11W
20LM	1710LM @30K/90CRI	400mA	14.5W
Notes	Delivered lumens based on 12D optic no lens, (see page 2)		

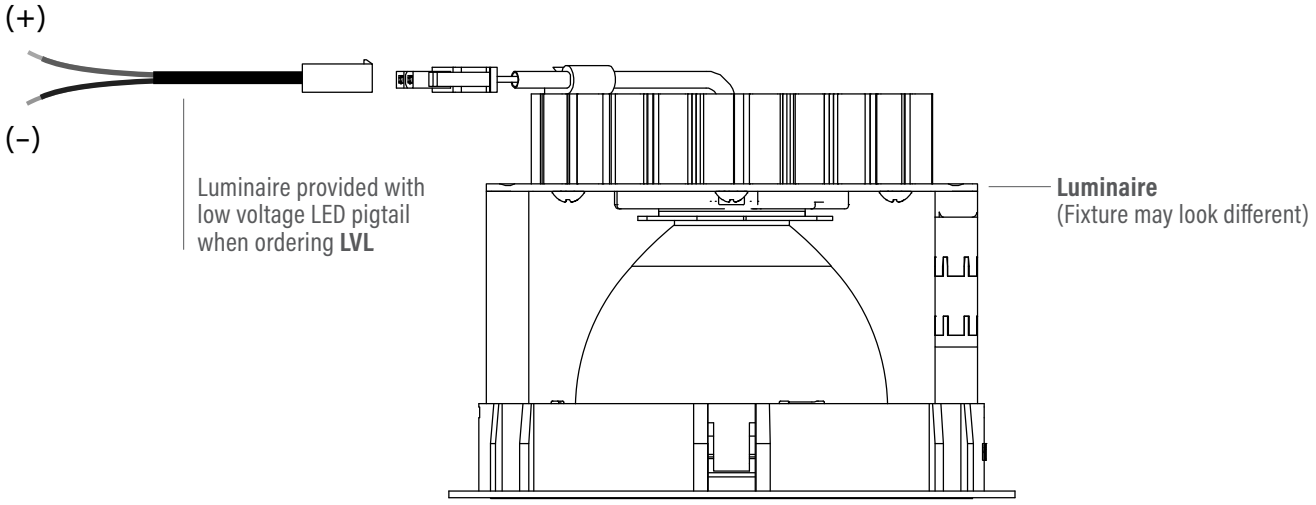
8° BEAM
(Note: Specifications are subject to change without notice)

6mm COB PERFORMANCE DATA

LED LIGHT ENGINE	NOMINAL DELIVERED LUMENS	DRIVE CURRENT	LED WATTAGE
10LM	790LM @30K/80CRI	225mA	8.5W
15LM	1250LM @30K/80CRI	350mA	13W
10LM	670LM @30K/90CRI	225mA	8.5W
15LM	1060LM @30K/90CRI	350mA	13W
Notes	Delivered lumens based on 8D optic no lens, (see page 2)		

NOMINAL LED VOLTAGE: 36VDC

Customer to order CC Remote Driver separately or POE Node by others.



alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

AWNR OPTIONS

Athena Wireless Node

The Athena wireless node is a radio frequency (RF) device that enables simple, digital control of individual light fixtures in an Athena control system.

OEM ADVANTAGE LUTRON

Athena Wireless Node RF

AWNR

Plenum rated and can be installed above the ceiling for wireless control of a fixture without any impact on fixture aesthetics.

FEATURES

- Enables individual, wireless control of each fixture in an Athena control system. Accommodates zone and control changes without rewiring.
- Installed at factory – no wiring required on-site. Fixture is ready to communicate wirelessly once power is connected.
- All drivers on the link are controlled as a single zone.

REGULATORY APPROVALS

- cULus Listed (UL916)
- Complies with requirements for use in other spaces used for environmental air (plenums) per NEC® 2014 300.22(C)(3).
- FCC compliant with the limits for a Class B digital device.
- IC (Industry Canada)
- ANSI C137.1 0–10 V- Electronic Off

POWER / LOAD

- IEC SELV/NEC® Class 2
- 1 Watt

ENVIRONMENTAL

- Ambient operating temperature (immediate vicinity of Athena wireless node): **32 °F to 131 °F** (0 °C to 55 °C), 0% to 90% humidity.

BATTERY OPTIONS

- For EM options please consult factory.

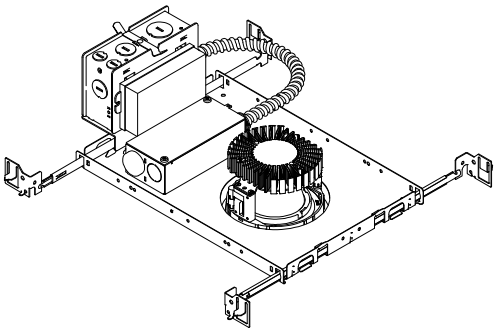
Note: Default behavior prior to programming

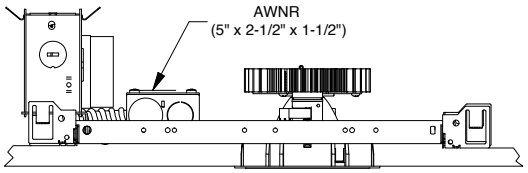
- Light level 100%
- Athena wireless node performs an unprogrammed startup sequence on every power up until the device is added to an Athena system.
- Each Athena wireless node should be installed within 25 ft (7.62 m) of two or more Athena wireless nodes or other Clear Connect – Type X devices.
- For Chicago plenum installations, the Athena wireless node may not be installed in the plenum space. It must be installed in the occupied space.

For servicing the driver/j-box, access above ceiling is required. (NC Mounting)

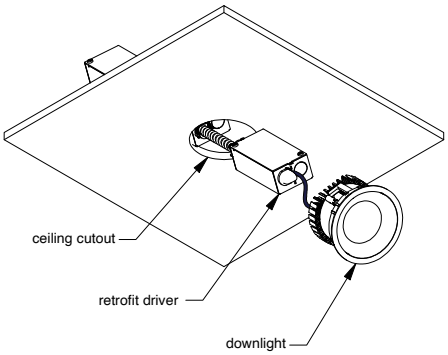
IC/ICAT/CP not available in AWNR.

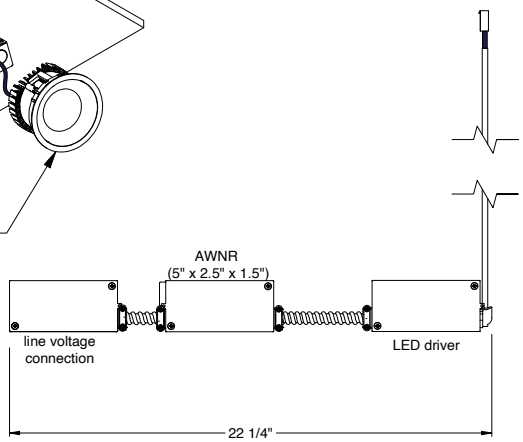
NC - NEW CONSTRUCTION





RET - RETRO FIT





101118

TROV® Flex

DATE	PROJECT	FIRM	TYPE

THE ALL-SILICONE, FLEXIBLE LUMINAIRE WITH OPTICS, TROV FLEX L09 PACKS 2-STEP COLOR CONSISTENCY INTO A DURABLE PACKAGE SUITABLE FOR BOTH EXTERIOR AND INTERIOR USE. ITS ULTRA-DISCREET PROFILE MAKES IT AN IDEAL FIT FOR APPLICATIONS WHERE SPACE IS A PREMIUM.

FEATURES:

- DIMMABLE TO 0%
- 3 BEAM ANGLES
- FIELD CUTTABLE EVERY 6 INCHES
- 24 VDC CLASS 2
- 90+ CRI
- IP67 RATED FOR OUTDOOR AND INDOOR APPLICATIONS

MODEL SIZE	INTERIOR/ EXTERIOR	LENGTH	POWER	CCT	CRI	VOLTAGE	OPTICS
	E	120			90	CV24	
L09	E - Exterior	120 - 120" (3048mm)	05 - 5W/ft 09 - 9W/ft	27 - 2700K 30 - 3000K 35 - 3500K 40 - 4000K	90 - 90CRI	CV24 - 24VDC	10x10 15x40 ASYM

NOTE: 120in spools come with a 12in leader cable attached and sealed inside the fixture. If cutting and reusing section, additional leader cables need to be ordered separately.

EXAMPLE: L09-E-120-05-27-90-CV24-15x40

PERFORMANCE	WATTS	OPTIC	LUMEN OUTPUT	EFFICACY	CBCP
	05	10x10	440 lm/FT (1,443 lm/m)	92 lm/W	4,345
		15x40	441 lm/FT (1,447 lm/m)	92 lm/W	700
		ASYM	428 lm/FT (1,405 lm/m)	89 lm/W	385
	09	10x10	714 lm/FT (2,344 lm/m)	84 lm/W	7,056
		15x40	716 lm/FT (2,350 lm/m)	84 lm/W	1,137
		ASYM	696 lm/FT (2,282 lm/m)	82 lm/W	626

ALL LUMEN DATA IS FROM 4000K 90CRI FIXTURES. PLEASE SEE PHOTOMETRY SPEC SHEET FOR ADDITIONAL LUMEN AND TM-30 DATA.

COLOR RENDERING INDEX	90+
COLOR CONSISTENCY	2-STEP MACADAM ELLIPSE

LUMEN DEPRECIATION / RATED LIFE	WATTS	L70 @ 25C
	5W-9W	>50,000

*CALCULATIONS FOR LED FIXTURES ARE BASED ON MEASUREMENTS THAT COMPLY WITH IES LM-80 TESTING PROCEDURES AND IES TM-21 CALCULATOR.

ELECTRICAL	**MAX POWER CONSUMPTION**	5W/ft = 4.8W (15.7W/m) ; 9W/ft = 8.7W/ft (28.5W/m)
	MAX FIXTURE RUN LENGTH	5W/ft = 20ft (Interior) 10ft (Exterior), 9W/ft = 10ft
	OPERATING VOLTAGE	24VDC
	DRIVER	REMOTE DRIVER SOLD SEPARATELY
	STARTUP TEMPERATURE	-4˚F TO 122˚F (-20˚C TO 50˚C)
	OPERATING TEMPERATURE	-4˚F TO 122˚F (-20˚C TO 50˚C)
	STORAGE TEMPERATURE	-40˚F TO 176˚F (-40˚C TO 80˚C)
PHYSICAL	**HOUSING/LENS**	SILICONE HOUSING AND LENS
	WEIGHT	2.22oz/ft ; (206.5g/m)
	CONNECTORS	INTEGRAL MALE AND FEMALE CONNECTORS
	ENVIRONMENT	OUTDOOR WET LOCATION IP67 FOR OUTDOOR, MARINE, AND NATATORIUM APPLICATIONS
	MOUNTING OPTIONS	STAINLESS STEEL MOUNTING BRACKET NEEDED EVERY 6 INCHES. **SOLD SEPARATELY.**
	CUT LENGTH	CUTTABLE EVERY 6 INCHES (152.4MM)
	BEND RADIUS	3IN (75MM) VERTICAL, 0IN (0MM) HORIZONTAL
CONTROL	**DIMMING**	0%-100%
FIXTURE RATING & CERTIFICATIONS	**UL AND CE LISTED** **RoHS COMPLIANT** **TITLE 24 JA8**	
LIMITED WARRANTY	**5 YEARS**	

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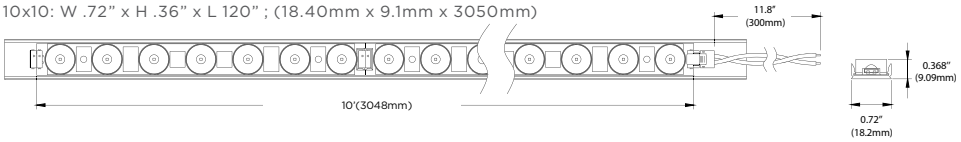
DATE	PROJECT	FIRM	TYPE

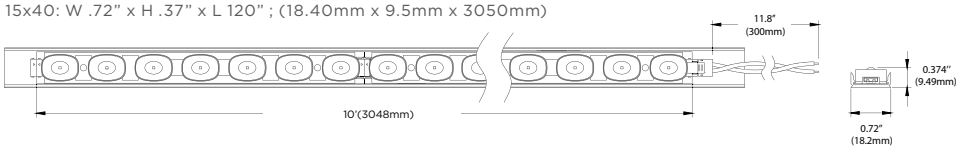
PHYSICAL

DIMENSIONS

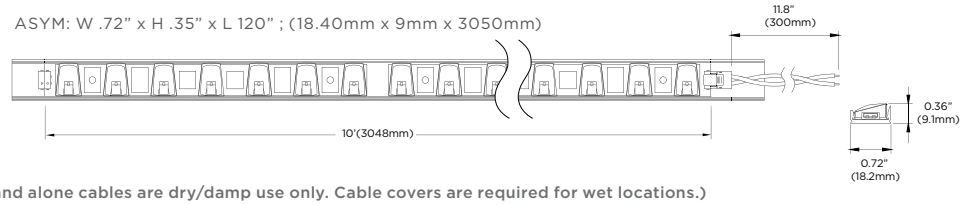
10x10: W .72" x H .36" x L 120" ; (18.40mm x 9.1mm x 3050mm)



15x40: W .72" x H .37" x L 120" ; (18.40mm x 9.5mm x 3050mm)



ASYM: W .72" x H .35" x L 120" ; (18.40mm x 9mm x 3050mm)



WIRING OPTIONS (Stand alone cables are dry/damp use only. Cable covers are required for wet locations.)

Cable Assembly, AVX Connector, Leader, 6 feet CBL-AVX-LDR-6ft
Cable Assembly, AVX Connector, Jumper, 4 inches CBL-AVX-JMP-4in
Cable Assembly, AVX Connector, Jumper, 12 inches CBL-AVX-JMP-12in
Cable Assembly, AVX Connector, Jumper, 6 feet CBL-AVX-JMP-6ft

L09 120 inch spools come with 12" wired leads. Leader and jumper cables are only needed when cutting to shorter lengths.

REMOTE DRIVER OPTIONS

MAGNETIC NORTH AMERICA

Driver, Magnetic, Exterior, MLV & TRIAC, 96W, 120/277V Dual Tap DRV-M-E-96W-120/277-SBC
Driver, Magnetic, Exterior, MLV & TRIAC, 60W, 120/277V Dual Tap DRV-M-E-60W-120/277-SBC
Driver, Magnetic, Exterior, MLV & TRIAC, 40W, 120/277V Dual Tap DRV-M-E-40W-120/277-SBC

ELECTRONIC NORTH AMERICA

Driver, Electronic, Exterior, 0-10V & TRIAC & ELV, 96W, 120-277V Multi-Volt DRV-E10-E-96W-120-277-LTF
Driver, Electronic, Exterior, 0-10V & TRIAC & ELV, 60W, 120-277V Multi-Volt DRV-E10-E-60W-120-277-LTF
Driver, Electronic, Exterior, 0-10V & TRIAC & ELV, 40W, 120-277V Multi-Volt DRV-E10-E-40W-120-277-LTF

MULTI-OUTPUT ELECTRONIC NORTH AMERICA

Driver, Electronic, Exterior, 0-10V & TRIAC & ELV, 96WX2, 100-277V Multi-Volt DRV-E10-E-96WX2-100-277-KVG
Driver, Electronic, Exterior, 0-10V & TRIAC & ELV, 96WX3, 100-277V Multi-Volt DRV-E10-E-96WX3-100-277-KVG
Driver, Electronic, Exterior, 0-10V & TRIAC & ELV, 96WX4, 100-277V Multi-Volt DRV-E10-E-96WX4-100-277-KVG

ELECTRONIC INTERNATIONAL

Driver, Electronic, Exterior, 0-10V, 100W, 100-305V Multi-Volt, CE Only DRV-E10-E-100W-100-305-ELG
Driver, Electronic, Exterior, DALI, 100W, 100-305V, Multi-Volt, CE Only DRV-DALI-E-100W-100-305-ELG
Driver, Electronic, Exterior, 0-10V, 120W, 90-305V Multi-Volt, CE Only DRV-E10-E-120W-90-305-PWM
Driver, Electronic, Exterior, DALI, 120W, 90-305V Multi-Volt, CE Only DRV-DALI-E-120W-90-305-PWM

See Remote Driver Spec Sheets for more details.
Drivers can be fully loaded.

VOLTAGE DROP CHART - WIRE GAUGE NEEDED FOR WIRE LENGTH FROM FIXTURE TO DRIVER

	Total Wattage per Run									
Wire Gauge	**10W .42 A**	**20W .83 A**	**30W 1.3 A**	**40W 1.7 A**	**50W 2.1 A**	**60W 2.5 A**	**70W 2.9 A**	**80W 3.3 A**	**90W 3.75 A**	**100W 4.2 A**
20 AWG	85 ft.	43 ft.	27 ft.	21 ft.	17 ft.	14 ft.	12 ft.	11 ft.	9 ft.	8 ft.
18 AWG	134 ft.	68 ft.	45 ft.	33 ft.	27 ft.	22 ft.	19 ft.	17 ft.	15 ft.	14 ft.
16 AWG	215 ft.	109 ft.	72 ft.	54 ft.	43 ft.	36 ft.	31 ft.	27 ft.	24 ft.	22 ft.
14 AWG	345 ft.	174 ft.	115 ft.	86 ft.	69 ft.	57 ft.	49 ft.	43 ft.	39 ft.	36 ft.
12 AWG	539 ft.	272 ft.	181 ft.	135 ft.	108 ft.	90 ft.	77 ft	68 ft.	61 ft.	56 ft.
10 AWG	784 ft.	397 ft.	263 ft.	197 ft.	158 ft.	131 ft.	112 ft.	98 ft.	97 ft.	82 ft.

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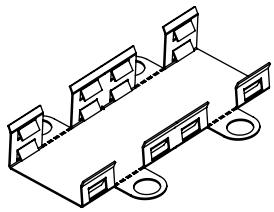
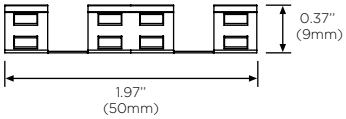
DATE	PROJECT	FIRM	TYPE

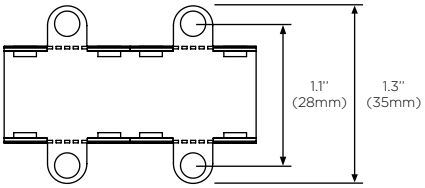
L09 MOUNTING ACCESSORIES

Mounting Bracket.....L09-A-MNT-BRKT

Mounting brackets need to be installed every 6 inches. Mounting brackets can be used in inverted applications.







Mounting Extrusions, Dust Covers, and Amiable Brackets

(See Extrusion Web page and Spec Sheet for more details)

• Mounting Extrusions can be used instead of the mounting brackets. There is a symmetrical profile for the 10x10 and 15x40, and an asymmetric profile for the ASYM optic. They come in 62in lengths, include a set of end caps, and are available in clear anodized, white, and black finishes. The extrusions have pre-drilled holes for mounting directly to the surface. They are field cuttable. Factory cutting is not available.

• Optional Aimable Brackets mount directly to mounting extrusions to provide up to 180-degree aiming. They will not mount directly to L09. 1 bracket is used for 12in and 2 brackets for 12in-60in extrusions.

• Option Dust Covers can be added to the top of the extrusions to keep dust and debris off L09. They come in symmetric and asymmetric options to coincide with the extrusions.

Symmetric Components

L09 Flat mounting extrusion, 62in, symmetric, clear anodized aluminum L09-A-MNT-EXT-SYM-62IN-AL
L09 Flat mounting extrusion, 62in, symmetric, white L09-A-MNT-EXT-SYM-62IN-WH
L09 Flat mounting extrusion, 62in, symmetric, black L09-A-MNT-EXT-SYM-62IN-BK
L09 Extrusion end cap set, symmetric, set of 2, black L09-A-MNT-EXT-SYM-ENDCAPS
L09 Extrusion end cap set, symmetric, set of 2, white L09-A-MNT-EXT-SYM-ENDCAPS-WH
L09 Clear dust cover, 62in, symmetric L09-A-DUSTCVR-SYM-62IN

Asymmetric Components

L09 Flat mounting extrusion, 62in, asymmetric, clear anodized aluminum L09-A-MNT-EXT-ASYM-62IN-AL
L09 Flat mounting extrusion, 62in, asymmetric, white L09-A-MNT-EXT-ASYM-62IN-WH
L09 Flat mounting extrusion, 62in, asymmetric, black L09-A-MNT-EXT-ASYM-62IN-BK
L09 Extrusion end cap set, asymmetric, set of 2, black L09-A-MNT-EXT-ASYM-ENDCAPS
L09 Extrusion end cap set, asymmetric, set of 2, white L09-A-MNT-EXT-ASYM-ENDCAPS-WH
L09 Clear dust cover, 62in, asymmetric L09-A-DUSTCVR-ASYM-62IN

Universal Components

L09 Extrusion Aiming Bracket, SYM and ASYM, set of 2, clear anodized L09-A-MNT-EXT-ADJ-BRKTS

Louvers

(See Extrusion web-page and spec sheet for more details)

• Louvers can be used to shield the optics and reduce glare. They are available in full and half shield for the 10x10 and 15x40 and half shielding for the ASYM optic.

• Louvers will only work with the mounting extrusions. They will not mount directly to L09.

• Louvers are specific to each mounting extrusion type, so order a symmetric louver when using the symmetric extrusion and an asymmetric louver when using the asymmetric extrusion.

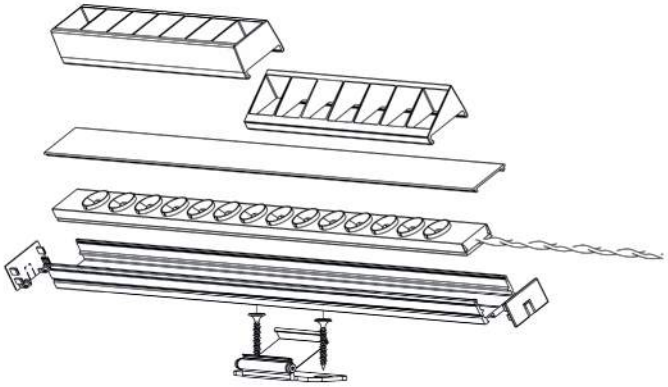
SYMMETRIC COMPONENTS

L09 Half Louver, Symmetric, 6in, black L09-A-SYM-HL
L09 Full Louver, Symmetric, 6in, black L09-A-SYM-FL

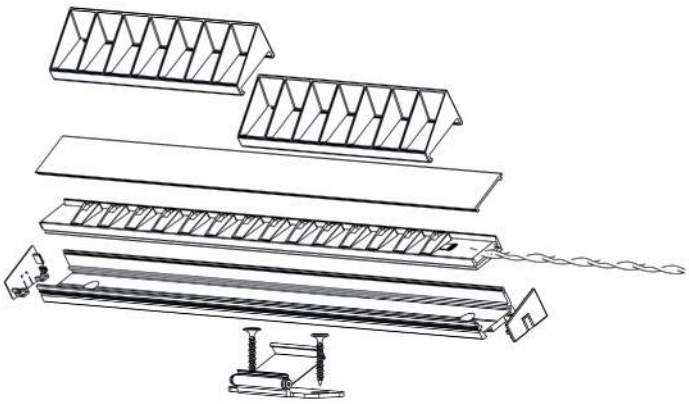
ASYMMETRIC COMPONENTS

L09 Half Louver, Asymmetric profile, 6in, black L09-A-ASYM-HL

SYMMETRIC EXTRUSION ASSEMBLY



ASYMMETRIC EXTRUSION ASSEMBLY



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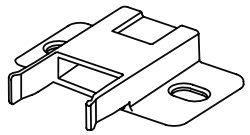
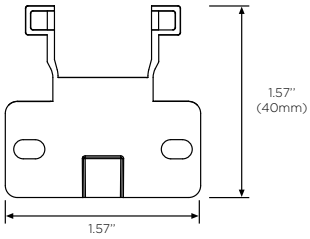
L09 CONNECTING ACCESSORIES

Terminator Cap..... L09-A-CAP

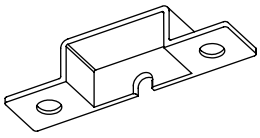
The terminator cap is only needed to seal the cut end of the fixture in wet locations. If the fixtures are not cut or are being installed in damp/dry locations, the terminator cap is not needed. One cap per cut is needed.

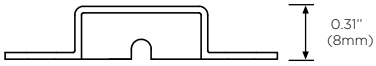


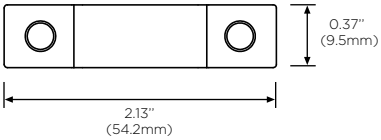


Strain Relief..... L09-A-SR

Strain reliefs are used to prevent accidental pull out of the AVX connector used on leader and jumper cables. They are not required but recommended for applications where the fixtures are accessible. Use one strain relief per leader cable and two per jumper cable.
Comes in a 5-Pack.





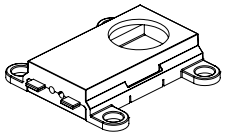


Cable Covers

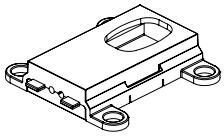
Cable Covers are used to provide a waterproof (IP66) seal over cable connections. One cable cover is needed per connection point. Cable covers are specific to each optic, so order based on the fixture optic being used. Cable covers have non-hardening silicone grease that prevents water ingress. This grease can only be used once, so if they are attached then removed, additional silicone grease will need to be added in the field. **Cable Covers will not fit inside the extrusion. Plan for them to stick out the ends.**

L09 Cable Cover for 10x10 ..... L09-A-CBLCVR-10x10
L09 Cable Cover for 15x40 ..... L09-A-CBLCVR-15x40
L09 Cable Cover for ASYM L09-A-CBLCVR-ASYM

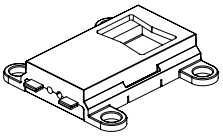
10x10



15x40



ASYM

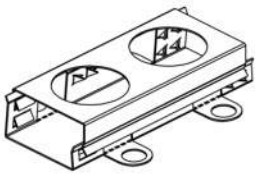


Connection Covers (Including Mounting Bracket)

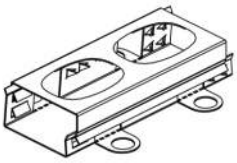
Connection Covers are used to provide a waterproof **(IP66)** connection between two cut sections of L09 that are joined together. They can be used to make two 10ft sections of 5W/ft into one 20ft run or used to join cut off sections into one long run. 9W/ft cannot exceed 10ft. The Connection Cover, and included mounting bracket, have non-hardening silicone grease preapplied that prevents water ingress into the cut connection. This grease can only be used once, so if they are attached then removed, additional silicone grease will need to be added in the field. Connection Covers are specific to each optic, so order based on the fixture optic being joined. **Connection covers will not fit inside extrusions. A 50mm gap in extrusion joints will be needed.**

L09 Connection Cover for 10x10, Includes Mounting Bracket..... L09-A-CONCVR-10x10
L09 Connection Cover for 15x40, Includes Mounting Bracket..... L09-A-CONCVR-15x40
L09 Connection Cover for ASYM, Includes Mounting Bracket..... L09-A-CONCVR-ASYM

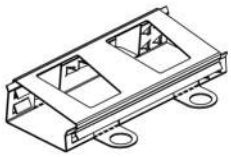
10x10



15x40

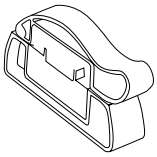


ASYM



Cutting Tool..... L09-A-CUTTOOL

The cutting tool ensures a clean safe cut that will not damage the optic or AVX connector. One cutter per installer is recommended.



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PHOTOMETRIC DATA

90 CRI

L90 5W

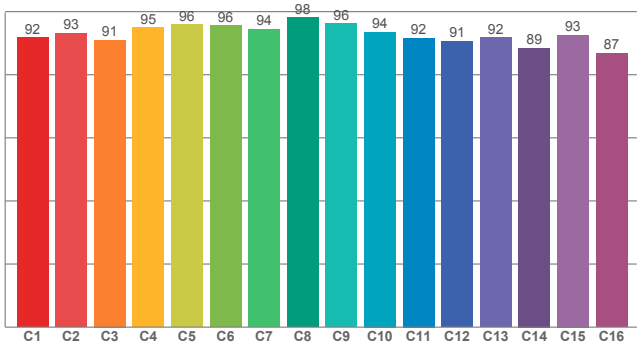
	10"x10"	15"x40"	ASYM
2700K			
Lumens	393	394	383
Efficacy	82	82	80
CBCP	3,886	720	366
3000K			
Lumens	415	416	404
Efficacy	86	87	84
CBCP	4,124	663	363
3500K			
Lumens	421	422	410
Efficacy	88	88	85
CBCP	3,420	670	272
4000K			
Lumens	440	441	428
Efficacy	92	92	89
CBCP	4,345	700	385

L90 9W

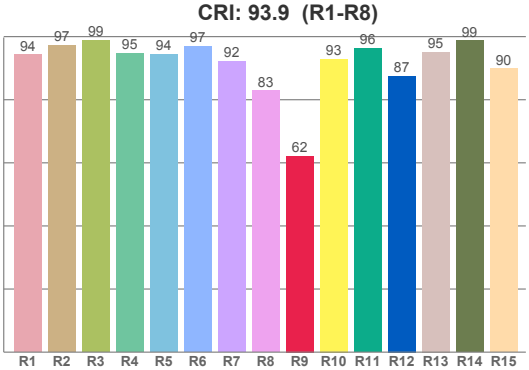
	10"x10"	15"x40"	ASYM
2700K			
Lumens	639	641	622
Efficacy	75	75	73
CBCP	6,311	1,016	560
3000K			
Lumens	674	676	656
Efficacy	79	79	77
CBCP	6,018	1,072	477
3500K			
Lumens	684	686	666
Efficacy	80	81	78
CBCP	6,371	1,088	492
4000K			
Lumens	714	716	696
Efficacy	84	84	82
CBCP	7,056	1,137	626

L09-E-012-05-27-90-CV24-ASYM (5 Watt, 2700K, 90 CRI, ASYM)

TM30: 92.9



CRI: 93.9 (R1-R8)



CRI R values, only R1-R8 are used to calculate final CRI value

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
94.28	97.21	98.79	94.72	94.38	96.97	92.20	82.84	62.18	92.95	96.30	87.50	95.14	98.72	89.85

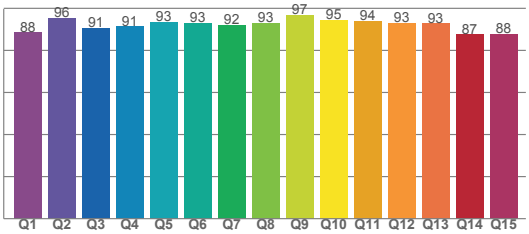
TM30 C values, 16 binned values out of total of 99 C values

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
91.77	93.08	91.02	94.86	95.88	95.52	94.44	98.14	96.23	93.53	91.61	90.62	91.74	88.51	92.59	86.81

CQS Q values

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
88.44	95.52	90.65	91.29	93.39	92.81	91.96	92.90	96.94	94.51	93.95	93.16	92.72	87.48	87.59

CQS: 91.6



Color parameters

CCT	CRI	CRI R9	TM30 Rf	TM30 Rg	CQS	x	y	u	v	Duv
2801 K	93.9	62.2	92.9	100.0	91.6	0.5	0.4	0.3	0.3	-0.0005

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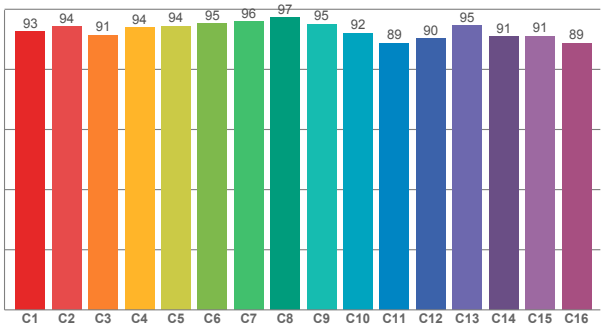
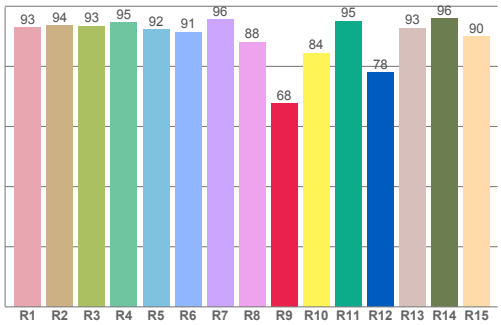
DATE	PROJECT	FIRM	TYPE

L09-E-012-05-35-90-CV24-ASYM (5 Watt, 3500K, 90 CRI, ASYM)

TM30: 92.8



CRI: 92.7 (R1-R8)



CRI R values, only R1-R8 are used to calculate final CRI value

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
93.00	93.52	93.42	94.64	92.18	91.45	95.53	88.06	67.62	84.46	95.04	77.90	92.74	95.83	89.90

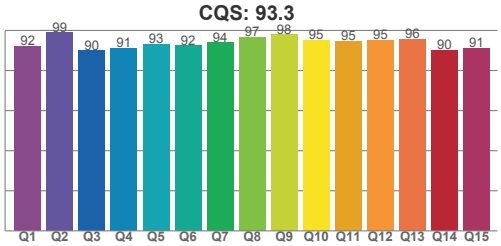
TM30 C values, 16 binned values out of total of 99 C values

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
92.59	94.22	91.47	93.94	94.40	95.28	95.91	97.31	95.10	92.05	88.74	90.31	94.52	90.84	91.10	88.81

CQS Q values

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
92.32	98.86	89.87	91.29	93.21	92.47	93.83	96.70	97.91	94.99	94.80	95.19	95.52	90.32	91.02

CQS: 93.3

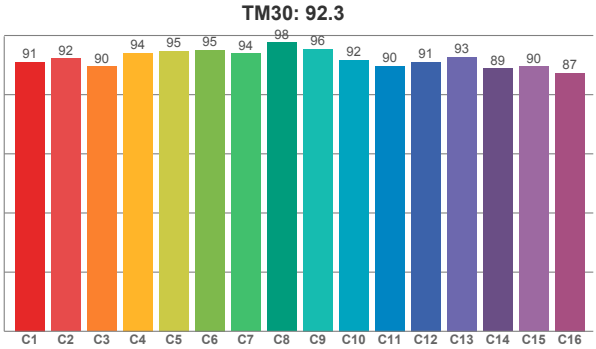


Color parameters

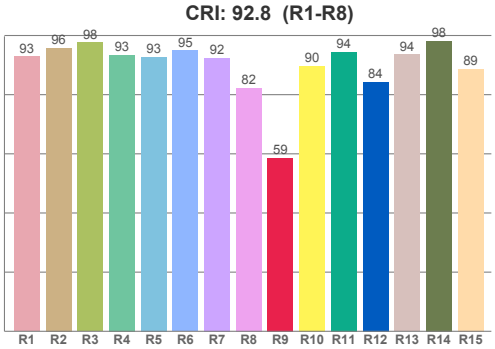
CCT	CRI	CRI R9	TM30 Rf	TM30 Rg	CQS	x	y	u	v	Duv
3459 K	92.7	67.6	92.8	100.1	93.3	0.4	0.4	0.2	0.3	0.0032

L09-E-012-09-30-90-CV24-ASYM (9 Watt, 3000K, 90 CRI, ASYM)

TM30: 92.3



CRI: 92.8 (R1-R8)



CRI R values, only R1-R8 are used to calculate final CRI value

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
92.86	95.81	97.66	93.48	92.77	94.98	92.42	82.23	58.67	89.68	94.46	84.25	93.61	98.18	88.71

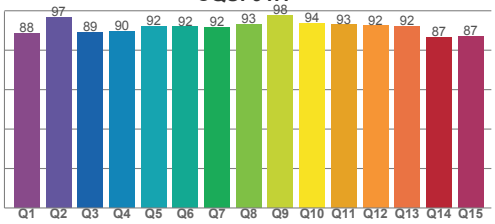
TM30 C values, 16 binned values out of total of 99 C values

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
91.12	92.21	89.56	94.11	94.77	95.19	93.90	97.66	95.52	91.80	89.64	91.12	92.73	88.87	89.51	87.29

CQS Q values

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
88.49	96.82	89.20	89.75	92.17	91.96	91.56	93.06	97.74	93.68	93.02	92.44	92.19	86.58	87.06

CQS: 91.1



Color parameters

CCT	CRI	CRI R9	TM30 Rf	TM30 Rg	CQS	x	y	u	v	Duv
3107 K	92.8	58.7	92.3	100.0	91.1	0.4	0.4	0.2	0.3	-0.0004

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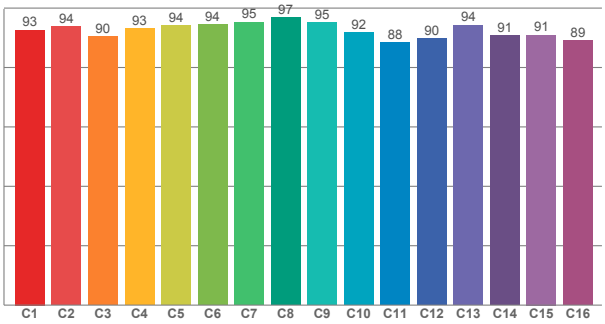
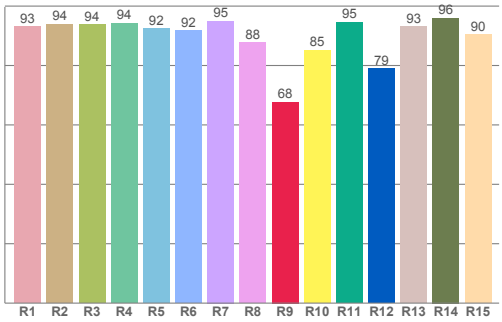
DATE	PROJECT	FIRM	TYPE

L09-E-012-09-35-90-CV24-10x10 (9 Watt, 3500K, 90 CRI, 10x10)

TM30: 92.4



CRI: 92.7 (R1-R8)



CRI R values, only R1-R8 are used to calculate final CRI value

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
93.17	93.91	93.71	94.24	92.43	91.78	94.96	87.75	67.70	85.14	94.59	79.04	93.06	95.97	90.34

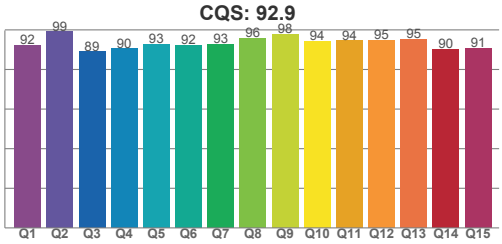
TM30 C values, 16 binned values out of total of 99 C values

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
92.61	93.84	90.36	93.03	94.05	94.43	95.26	96.82	95.04	91.84	88.34	89.76	94.24	90.81	90.98	88.97

CQS Q values

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
92.18	99.00	88.95	90.44	92.90	92.14	92.78	95.91	97.87	94.20	94.48	94.86	95.18	90.31	90.88

CQS: 92.9



Color parameters

CCT	CRI	CRI R9	TM30 Rf	TM30 Rg	CQS	x	y	u	v	Duv
3469 K	92.7	67.7	92.4	100.6	92.9	0.4	0.4	0.2	0.3	0.0017

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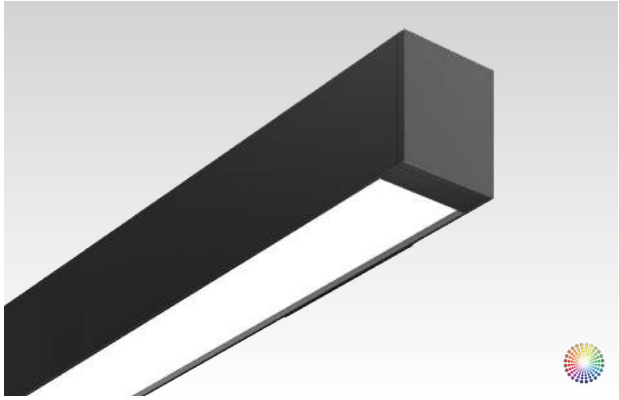
Extend 2

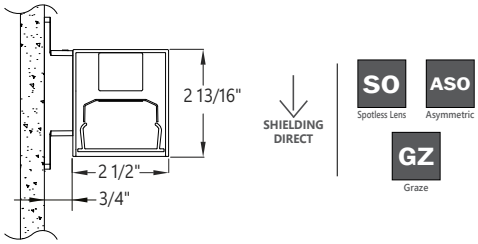
RGB+W Mullion mount



Project _____

Type _____

Notes _____



PERFORMANCE PER LINEAR FOOT

NOMINAL LUMEN OUTPUT	INPUT WATTS*	EFFICACY	SHIELDING
1000 lm/ft	16.4 W/ft	61 lm/W	SO
1050 lm/ft	16.4 W/ft	64 lm/W	GZ
1000 lm/ft	16.4 W/ft	61 lm/W	ASO
1000 lm/ft	16.4 W/ft	61 lm/W	BW
1000 lm/ft	16.4 W/ft	61 lm/W	WW

*Please consult factory for custom lumen output and wattage.

Ordering Guide

EX2WD													
PRODUCT ID		**NOM. LUM/FT**		**CRI**		**COLOR TEMP.**		**SHIELDING**		**LENGTH (FT)**		**FINISH**	
EX2WD	Extend 2 RGB+W Wall Mount Direct	**1000**	1000 lm/ft	**90**	90 CRI	**CTRGBW30**	RGB+30K White - Color Tuning	**SO**	spotless lens	**4**	4′	**AP**	aluminum paint
						CTRGBW35	RGB+35K White - Color Tuning	**GZ**	Graze	**5**	5′	**W**	white
						CTRGBW40	RGB+40K White - Color Tuning	**ASO**	Asymmetric	**6**	6′	**BLK**	black
										7	7′	**C**	custom
										8	8′		
										12	12′		
										S(L)	System Run		
								Choose only one of the options		3" increments are available for lengths over 4 feet.			

		CT(DMX)				WB							
VOLTAGE		**DRIVER**		**CIRCUITS**		**MOUNTING**		**OTHER (OPTIONAL)**		**CUSTOM(OPT.)**	
120	120 V	**CT(DMX)**	color tuning driver	**1**	1 circuit	**WB**	wall bracket	**+TF**	top feed*	**C**	custom
277	277 V			**+E(#)**	emergency circuit*			**+EF**	end feed*		
UNV	universal							**+N**	natatorium finish		
				*Specify quantity. Minimum 3ft fixture length.				* See page 3 for more details.		Please specify	

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CONSTRUCTION

Housing	Extruded aluminum (0.08'' nominal) Up to 70% recycled content
End Cap	Cast aluminum
Interior Brackets	Die formed sheet steel (18 gauge)
Gaskets	Silicone rubber
Lens Gaskets	Extruded elastomer
Lens	Extruded acrylic
Fasteners	All external fasteners are tamper proof TORX T20

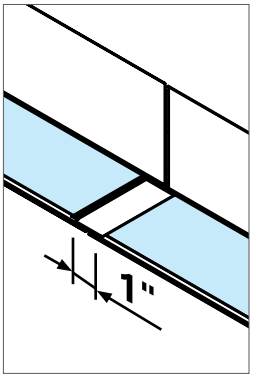
OPTICS

SO	Spotless lens;
ASO	Asymmetric Spotless lens;
GZ	Graze.

Impact modified PMMA lens used for all shielding options.

SYSTEM (S(L))

Lengths of 4'-12' standalone are available. Runs of EXTEND2 that are greater than 12' in length are designated as systems (S(L)). System runs are comprised of a combination of 4' to 8' sections to be assembled on site using our joining system which includes a 1" sealed joiner plate. For more information on systems and joining, please refer to the EXTEND2 installation sheets available for download at www.axislighting.com.



WEIGHT

4 ft	8 lbs / 3.6 kg
8 ft	16 lbs / 7.2 kg
12 ft	24 lbs / 10.8 kg

FINISH

Powder coated, custom finishes are available.

OTHER MOUNTING OPTIONS

EXTEND 2 is also available with pendant, wall, surface, and recessed mount options.

Specification sheets and installation sheets for all mountings for EXTEND 2 luminaires are available for download at www.axislighting.com

ELECTRICAL

Color Tuning CT driver	**DMX** - Standard
Emergency	Emergency circuit optional.
Input Voltage	120V, 277V, UNV.

Incorporating these components may have limitations or affect the length of the luminaire. Please contact factory for more details.

LED SYSTEM

CRI	90 color rendering index.
CRI Color Tuning	**90 CRI for CTRGBW.** **Note: RGB+W allows you to select the 'white point' (CCT) + CRI, delivering a more flexible and powerful white than standard RGBW.**
CCT Color Tuning	**30** (3000K) **35** (3500K) **40** (4000K)
LED life	Minimum 50,000h with 85% of lumen maintenance in 25^{0}C ambient temperature, in compliance with IES LM-80 testing measurements.
Thermal Management	Aluminum housing acting as the heat sink to maximize life.
Environment	Dry and wet location rated IP66 for outdoor or indoor use. Impact resistant rated IK10.

APPROVALS

Certified wet locations to UL and CUL standards.
IP66 and IK10 rated.

WARRANTY

Limited 5-year warranty is available. Warranty is valid provided luminaires are installed and used according to specifications. For full terms and conditions, please consult warranty section at axislighting.com.

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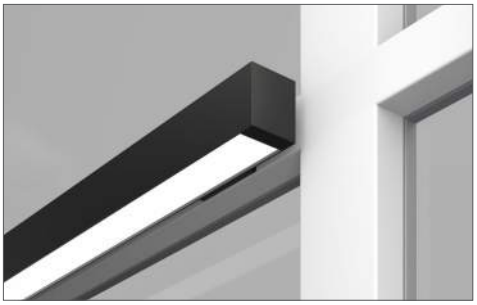
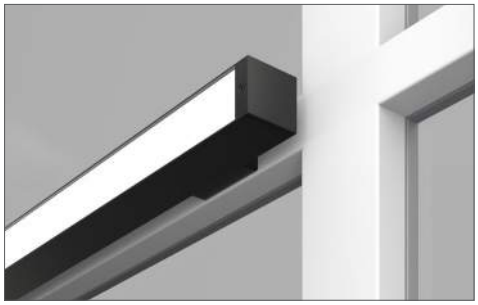
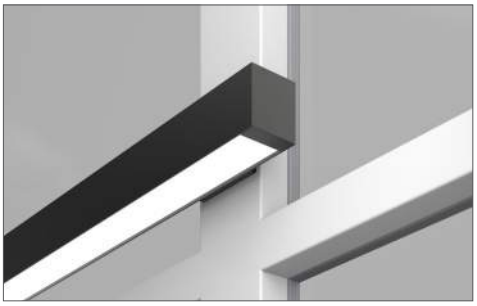
MOUNTING OPTIONS



HMD HORIZONTAL MULLION DOWN



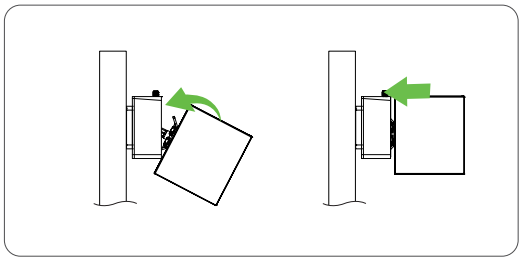
HMO HORIZONTAL MULLION OUT



HVMD HORIZONTAL TO VERTICAL MULLION DOWN

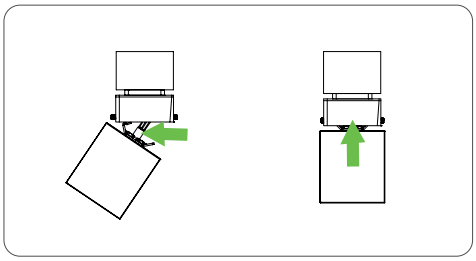
VMO VERTICAL MULLION OUT

HORIZONTAL MOUNTING DETAILS



SIDE VIEW

VERTICAL MOUNTING DETAILS



TOP VIEW

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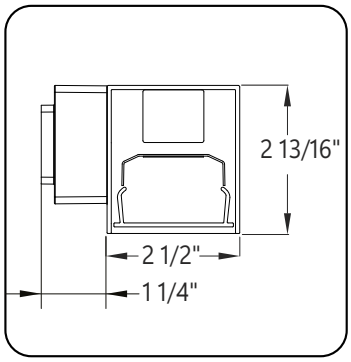
SECTION VIEWS

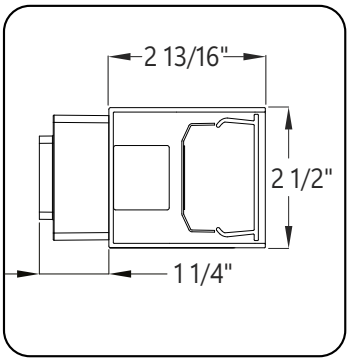
HMD HORIZONTAL MULLION DOWN

HVMD HORIZONTAL TO VERTICAL MULLION DOWN



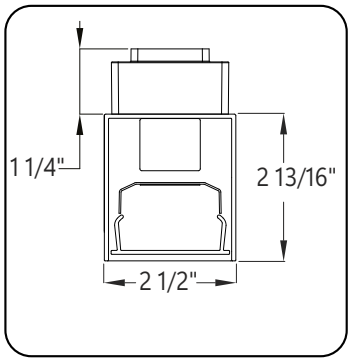
SO Spotless lens
ASO Asymmetric lens

HMO HORIZONTAL MULLION OUT



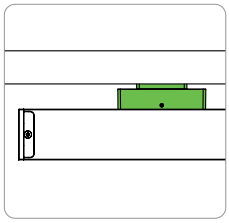
SO Spotless lens
ASO Asymmetric lens

VMO VERTICAL MULLION OUT



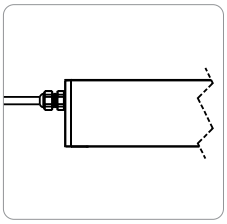
SO Spotless lens
ASO Asymmetric lens

POWER FEED



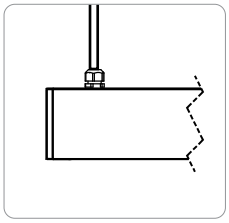
WIRING THROUGH BRACKET

STANDARD



EF END FEED

OPTIONAL



TF TOP FEED

OPTIONAL

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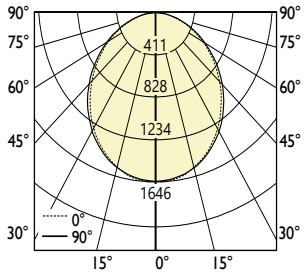
● PHOTOMETRIC DATA

SO - Spotless lens

1000 lm/ft

PHOTOMETRIC CURVE



Lumen/ft: 1000 lm/ft
Total Lumens: 4000 lm (for 4ft)
Input Watts: 65.41 W
Efficacy: 61 lm/W
IES FILE: EX2xx-1000-90-CTRGBW30-SO-4.ies

TESTED ACCORDING TO IES LM-79-2019

CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	0	22.5	45	67.5	90
0	1646	1646	1646	1646	1646
5	1634	1628	1630	1627	1633
15	1546	1540	1538	1534	1533
25	1383	1377	1372	1361	1360
35	1170	1165	1155	1139	1139
45	932	928	920	902	901
55	691	685	680	661	660
65	453	447	442	427	423
75	225	222	216	204	203
85	45	43	40	33	33
90	3	3	3	3	3

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	155
10-20	434
20-30	633
30-40	725
40-50	712
50-60	611
60-70	441
70-80	235
80-90	55
90	

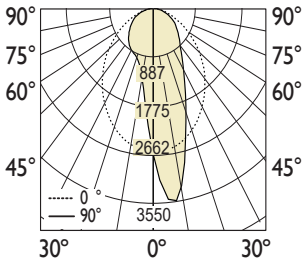
LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	**0**	**45**	**90**
45	37266	36808	36045
55	34040	33539	32522
65	30318	29548	28317
75	24629	23651	22226
85	14481	12871	10860

GZ Graze

1050 lm/ft

PHOTOMETRIC CURVE



Lumen/ft 1050 lm/ft
Total Lumens: 4205 lm (for 4ft)
Input Watts: 65.41 W
Efficacy: 64 lm/W
IES FILE: EX2xx-1050-90-CTRGBW30-GZ-4.ies

TESTED ACCORDING TO IES LM-79-2019

CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	**0**	**22.5**	**45**	**67.5**	**90**
0	2979	2979	2979	2979	2979
5	2960	3260	3447	3527	3550
15	2775	3341	2993	2582	2469
25	2389	2694	1955	1580	1503
35	1831	1833	1230	1060	1045
45	1202	1113	828	808	825
55	722	653	568	599	620
65	397	373	353	385	390
75	178	172	171	174	166
85	37	38	39	35	35
90	5	4	3	3	3

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	269
10-20	641
20-30	770
30-40	756
40-50	663
50-60	525
60-70	359
70-80	181
80-90	42
90	

LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	**0**	**45**	**90**
45	23874	16439	16396
55	17690	13915	15181
65	13180	11741	12964
75	9675	9276	9004
85	5938	6224	5708

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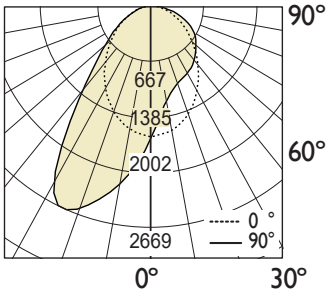
● PHOTOMETRIC DATA

WW Walwash

1000 lm/ft

PHOTOMETRIC CURVE



Lumen/ft: 1000 lm/ft
Total Lumens: 3997 lm (for 4ft)
Input Watts: 65.41 W
Efficacy: 61 lm/W
IES FILE: EX2xx-1000-90-CTRGBW30-WW-4.ies

TESTED ACCORDING TO IES LM-79-2019

CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	0	22.5	45	67.5	90
0	1648	1648	1648	1648	1648
5	1635	1538	1468	1414	1407
15	1518	1269	1140	1081	1067
25	1291	1006	927	917	924
35	1005	781	773	818	848
45	716	589	630	717	763
55	484	419	477	585	639
65	300	272	314	417	459
75	151	138	161	209	217
85	33	31	34	29	28
90	4	5	5	4	4

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	156
10-20	457
20-30	724
30-40	816
40-50	706
50-60	541
60-70	366
70-80	186
80-90	44
90	

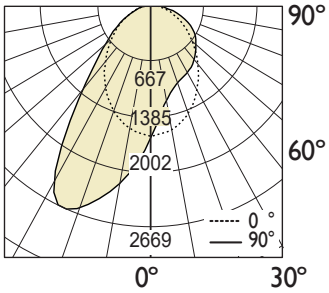
LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	0	45	90
45	14225	12525	15150
55	11854	11681	15643
65	9986	10446	15255
75	8182	8731	11794
85	5244	5548	4589

ASO Asymmetric

1000 lm/ft

PHOTOMETRIC CURVE



Lumen/ft: 1000 lm/ft
Total Lumens: 3997 lm (for 4ft)
Input Watts: 65.41 W
Efficacy: 61 lm/W
IES FILE: EX2xx-1000-90-CTRGBW30-ASO-4.ies

TESTED ACCORDING TO IES LM-79-2019

CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	0	22.5	45	67.5	90
0	1648	1648	1648	1648	1648
5	1635	1538	1468	1414	1407
15	1518	1269	1140	1081	1067
25	1291	1006	927	917	924
35	1005	781	773	818	848
45	716	589	630	717	763
55	484	419	477	585	639
65	300	272	314	417	459
75	151	138	161	209	217
85	33	31	34	29	28
90	4	5	5	4	4

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	156
10-20	457
20-30	724
30-40	816
40-50	706
50-60	541
60-70	366
70-80	186
80-90	44
90	

LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	0	45	90
45	14225	12525	15150
55	11854	11681	15643
65	9986	10446	15255
75	8182	8731	11794
85	5244	5548	4589

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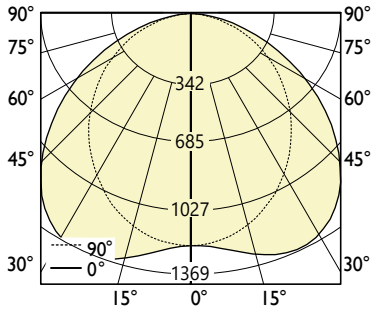
● PHOTOMETRIC DATA

BW Batwing

1000 lm/ft

PHOTOMETRIC CURVE



Lumen/ft 1000 lm/ft
Luminaire Lumens: 3997 lm
Input Watts: 65.41 W
Efficacy: 61 lm/W
IES FILE: EX2xx-1000-90-CTRGBW30-BW-4.ies

TESTED ACCORDING TO IES LM-79-2019

CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	**0**	**22.5**	**45**	**67.5**	**90**
0	1193	1193	1193	1193	1193
5	1186	1189	1196	1203	1206
15	1129	1151	1209	1265	1287
25	1025	1077	1202	1316	1359
35	886	962	1141	1281	1331
45	728	811	1004	1130	1165
55	556	627	797	879	896
65	376	423	539	577	576
75	191	213	265	262	258
85	39	43	46	37	38
90	4	4	4	5	5

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	114
10-20	343
20-30	554
30-40	707
40-50	756
50-60	685
60-70	509
70-80	268
80-90	60
90	

LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	**0**	**45**	**90**
45	14471	19946	23147
55	13621	19526	21947
65	12507	17930	19141
75	10391	14408	14021
85	6264	7398	6090

All IES files for other lamping are available for download at: www.axislighting.com

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DATE	PROJECT	FIRM	TYPE

THE L50 INCLUDES PATENTED OPTICAL DESIGN THAT DELIVERS THE WIDEST RANGE OF BEAM ANGLE OPTIONS FOR PRECISE COVE, WALL GRAZING, WALL WASHING OR LINE OF LIGHT APPLICATIONS. EXCLUSIVE FLIP TO FLAT™ HINGE DESIGN PROVIDES FLEXIBILITY WHEN MANAGING SMALL COVE DETAILS. TROV OFFERS SMOOTH, FLICKER FREE DIMMING DOWN TO 0%.

FEATURES :

- DIM TO 0%, ELV REVERSE PHASE
- 24 BEAM ANGLES
- MULTI-VOLT
- FLIP TO FLAT™
- 6 CCT OPTIONS
- 80+ AND 90+ CRI OPTIONS
- IP54 INTERIOR AND IP66 EXTERIOR OPTIONS

MODEL/ SIZE	INTERIOR/ EXTERIOR	LENGTH	POWER	CCT		CRI	VOLTAGE	OPTICS	
L50 **ON DEMAND SHIPPING**	I E	12″ 48″	02 04 06 08 10 12	**WHITE CCT** 27 30 35 40	**MONO COLOR**	80 90*	MULT (120-277V)	**GRAZING** 9 x 9 9 x 17 9 x 29 9 x 59 15 x 15 15 x 23 15 x 35 15 x 65 **COVE** 120** Asym **LINE OF LIGHT** LOL	**WASHING** 25 x 25 25 x 33 25 x 45 25 x 75 39 x 9 55 x 25 40 x40 40 x 48 40 x 60 40 x 90 45 x 15 70 x 40 70 x 70
BUILD TO ORDER SHIPPING				22 50	BL GR**** AM RD***	Blank For Color			

EXAMPLE: L50-I-48-10-27-90-MULT-15x65

*90 CRI not available in 2200K or 5000K **120 CRI is only available with Exterior option. See L35 spec sheet for interior cove options. ***Red is not available in 12W or 10W. ****Green is not available in 12W.

PERFORMANCE	WATTS	OPTIC	LUMEN OUTPUT	EFFICACY
	2W	ASYM	125 lm/LF (409 lm/m)	62 lm/W
	4W	ASYM	307 lm/LF (1006 lm/m)	77 lm/W
	6W	ASYM	489 lm/LF (1603 lm/m)	81 lm/W
	8W	ASYM	681 lm/LF (2232 lm/m)	85 lm/W
	10W	ASYM	824 lm/LF (2704 lm/m)	82 lm/W
	12W	ASYM	958 lm/LF (3144 lm/m)	80 lm/W

ALL LUMEN DATA IS FROM 4000K 80CRI FIXTURES. PLEASE SEE PHOTOMETRY SPEC SHEET FOR ADDITIONAL LUMEN DATA.

COLOR RENDERING INDEX 80+, 90+

COLOR CONSISTENCY 2-STEP MACADAM ELLIPSE

LUMEN DEPRECIATION / RATED LIFE

WATTS	L70 @ 25C	L70 @ 50C	L90 @ 25C	L90 @ 50C
2W-12W	>150,000	>70,000	>50,000	>25,000

* CALCULATIONS FOR LED FIXTURES ARE BASED ON MEASUREMENTS THAT COMPLY WITH IES LM-80 TESTING PROCEDURES AND IES TM-21 CALCULATOR

ELECTRICAL

POWER CONSUMPTION 2W*/LF (6.6W/M) ; 4W/LF (13.2W/M) ; 6W/LF (19.8W/M) ; 8W/LF (26.4W/M) ; 10W/LF (33W/M) ; 12W/FL (39.6W/M)
* 3W/LF (9.9W/M) at 220V-277V

MAX FIXTURE RUN LENGTH

	2W/LF		4W/LF		6W/LF		8W/LF		10W/LF		12W/LF	
Volts	Max Run all 1'	Max Run all 4'	Max Run all 1'	Max Run all 4'	Max Run all 1'	Max Run all 4'	Max Run all 1'	Max Run all 4'	Max Run all 1'	Max Run all 4'	Max Run all 1'	Max Run all 4'
120	214	214	186	186	152	152	114	114	91	91	76	76
220	374	392	340	340	277	277	209	209	95	167	95	139
277	374	494	374	428	349	349	263	263	95	190	95	175

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FREEDOM TO CREATE™

DATE	PROJECT	FIRM	TYPE

	POWER FACTOR	4W, 6W, 8W, 10W, 12W >0.9, 2W<0.9
	OPERATING VOLTAGE	MULTIVOLT: 110-277VAC, 50/60 Hz
	DRIVER	INTEGRAL TO FIXTURE; DE-RATED POWER AND SYNCHRONOUS START-UP AT FULL BRIGHTNESS
	STARTUP TEMPERATURE	-40˚F TO 122˚F (-40˚C TO 50˚C)
	OPERATING TEMPERATURE	-40˚F TO 122˚F (-40˚C TO 50˚C)
	STORAGE TEMPERATURE	-40˚F TO 176˚F (-40˚C TO 80˚C)
CONTROL	DIMMING	110-277VAC, ELV TYPE 0.07%-100%, REVERSE PHASE, TRAILING EDGE ETC control systems require 0-10V control using EcoSense LDCM. TROV will not work with ETC phase dimmers.
PHYSICAL	DIMENSIONS	W 1.6" x H 2" x L 12"/48" ; (41.6mm x 50.5mm x 304.7mm/1201mm)
	HOUSING /LENS	EXTRUDED ALUMINUM; UV STABILIZED POLYCARBONATE; STAINLESS STEEL FASTENERS; PLASTIC ENDCAPS RUBBER OVERMOLD FOR CABLE ASSEMBLY
	WEIGHT	1.52LBS / 0.69KG (1FT) ; 4.95LBS / 2.25KG (4FT)
	CONNECTORS	INTEGRAL MALE/FEMALE CONNECTORS
	ENVIRONMENT	INDOOR • ETL CERTIFIED FOR DRY/DAMP LOCATIONS IP54 OUTDOOR • ETL CERTIFIED FOR WET LOCATIONS IP66 IMPACT RATED TO IK10 Not intended to be used in water features such as waterfalls, fountains, etc.
	BEAM ANGLE	GRAZING, WASHING, COVE, ASYMMETRIC, LINE OF LIGHT
	MOUNTING OPTIONS	INTEGRAL MOUNTING AND ADJUSTABLE AIMING FROM 0˚-180˚ IN 15˚ INCREMENTS
FIXTURE RATING & CERTIFICATIONS	ETL CERTIFIED RoHS COMPLIANT RCM CERTIFIED	Title 24 JA8-2016 *90 CRI models only
LIMITED WARRANTY	5 YEARS	

WIRING OPTIONS (MVOLT): 110-277VAC

Power Cable Assembly, TROV, Leader/Jumper, 10 foot **CBL-3P-L-UNV-10***
Power Cable Assembly, TROV, Leader/Jumper, 50 foot **CBL-3P-L-UNV-50***
Power Cable Assembly, TROV, Jumper, 5 foot **CBL-3P-L-UNV-05****
Power Cable Assembly, TROV, Jumper, 1 foot **CBL-3P-L-UNV-01****
Power Cable Assembly, TROV, Adjustable Jumper, 0" to 7" **CBL-3P-L-UNV-ADJ**
Power Cable Assembly, TROV, Male and Female terminator caps **CBL-3P-L-UNV-CAPS**

*Two (2) terminators are included with the 10' and 50' power cable. One Leader need per circuit/fixture run. Cables are not plenum rated.
** If using the 5' or 1' power cable assembly as a leader to power, a run one set of CBL-3P-L-UNV-CAPS will also be needed per cable.

0-10V CONTROL OPTIONS

100-120VAC / 277VAC Linear Dimming Control Module 0-10V - Plenum Rated **LDCM-PL-120-277-010V-GR**

All products come standard with ELV dimming capabilities. 0-10V Control options required for operation at 0-10V.

OPTIONAL ACCESSORIES

Mounting

Mounting Track and Clips Set, 48 Inch Track, 8 Clips ..... **MNT-L-TRKCLIP-48** ..... 48" track and clips set will work with one 48" fixture or four 12" fixtures. (FOR INTERIOR USE ONLY)
Mounting Track and Clips Set, 12 Inch Track, 2 Clips ..... **MNT-L-TRKCLIP-12** ..... 12" track will not work with 48" fixtures. (FOR INTERIOR USE ONLY)
Mounting Track Clip, TROV, Set of 2 ..... **MNT-L-CLIP** ..... Clips needed = 12" fixtures need 1 set of 2 and 48" fixture needs 2 sets of 2.
90 Degree L bracket, TROV, Set of 2 ..... **MNT-L-LBKT** ..... L-Brackets needed = 12" fixtures need 1 set of 2 and 48" fixture needs 1 set of 2.
Angle Locking Clip, TROV, Pack of 10 ..... **MNT-L-ANGLOCK** ..... Angle Locks needed = 12" fixtures need 1 and 48" fixtures need 2. (Must order separately)
Mounting, Fine Adjustment Bracket, TROV ..... **MNT-L-FAB** ..... Fine Adjustment Brackets needed = 12" fixtures need 1 and 48" fixtures need 2.
*Fine Adjustment Bracket is highly recommended for Grazing Optics.
Mounting, Fine Adjustment L-Bracket, TROV ..... **MNT-L-LFAB** ..... Fine Adjustment L-Brackets needed = 12" fixtures need 1 and 48" fixtures need 2.
*Fine Adjustment L-Bracket is recommended for Asymetric Optics when aiming is needed.

Wall Mount Arm

Wall Mount Arm, 6 inch, TROV **WMA-L-CA-06**
Wall Mount Arm, 12 inch, TROV **WMA-L-CA-12**
Wall Mount Arm, 18 inch, TROV **WMA-L-CA-18**
Wall Mount Arm, 24 inch, TROV **WMA-L-CA-24**
Wall Mount Arm End Plate Set, TROV, Includes Left and Right ..... **WMA-L-END**
Wall Mount Arm Joiner Plate, TROV ..... **WMA-L-JNR**

Wall Mount Arms needed = For individual fixture installations two arms and one end set will be needed per fixture. For continuous run installation one end set will be needed per run. Each end set contains one left and one right end plate. One joining set wll be needed per joint. One arm per fixture will be needed plus one extra arm to complete the run. For example: A 10ft run made with two 4ft and two 1ft fixtures will contain; 1 x WMA-L-END, 3 x WMA-L-JNR, and 5 x WMA-L-CA-12. Leader cables are not included with wall mount arms, end sets, or joiners sets.

Masking Plates

Masking Plate, 3 inch high, 12 inch, L50 & L35 ..... **MP-L50-3H-12**
Masking Plate, 3 inch high, 48 inch, L50 & L35 ..... **MP-L50-3H-48**

Masking Plates needed = One 12" plate is needed per 12" fixture and one 48" plate is needed per 48" fixture.

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FREEDOM TO CREATE™

DATE	PROJECT	FIRM	TYPE

Landscape Stake

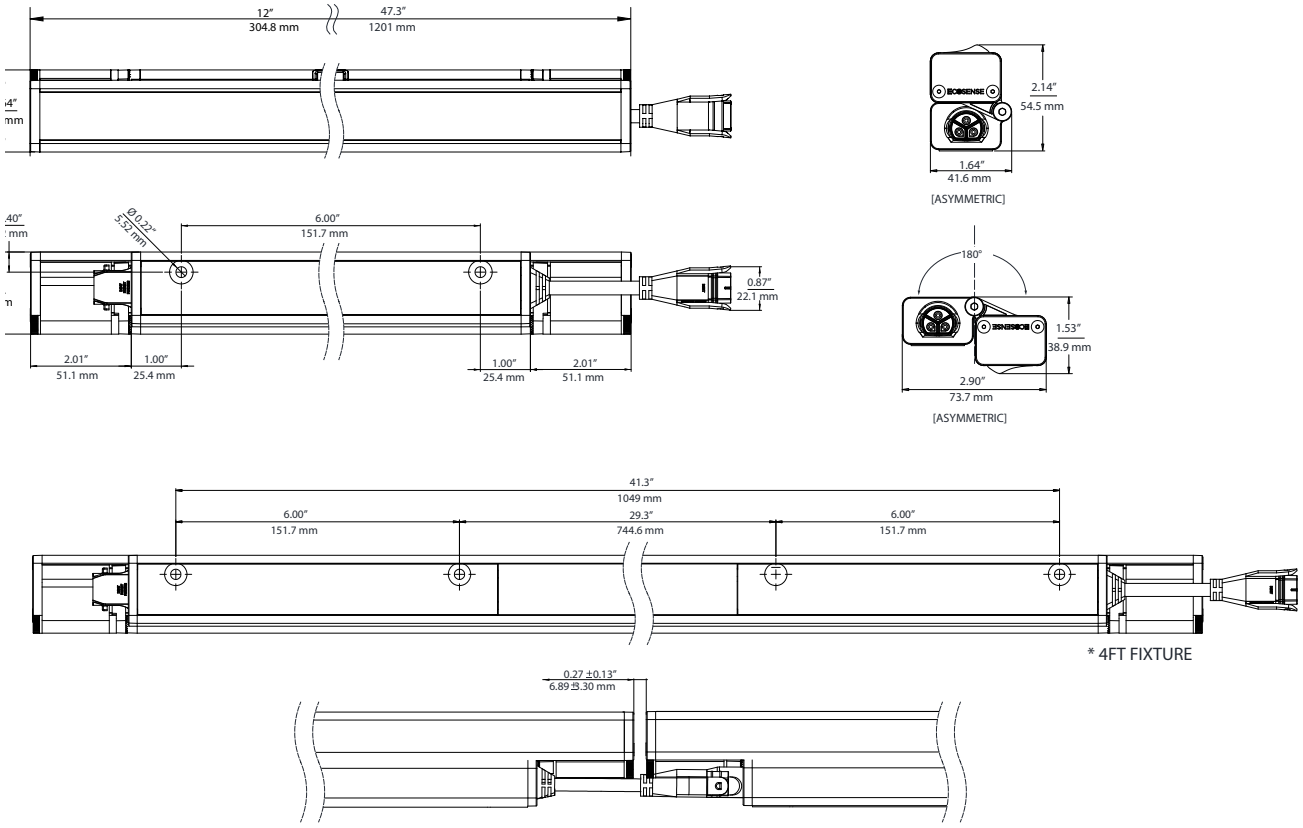
Landscape Stake, 6 inch, TROV, Set of 2 ..... LS-L-STK-06
Landscape Stake, 12 inch, TROV, Set of 2 ..... LS-L-STK-12
Landscape Stake, 18 inch, TROV, Set of 2 ..... LS-L-STK-18

Landscape Stakes needed = 12" and 48" fixtures both need one set of 2.

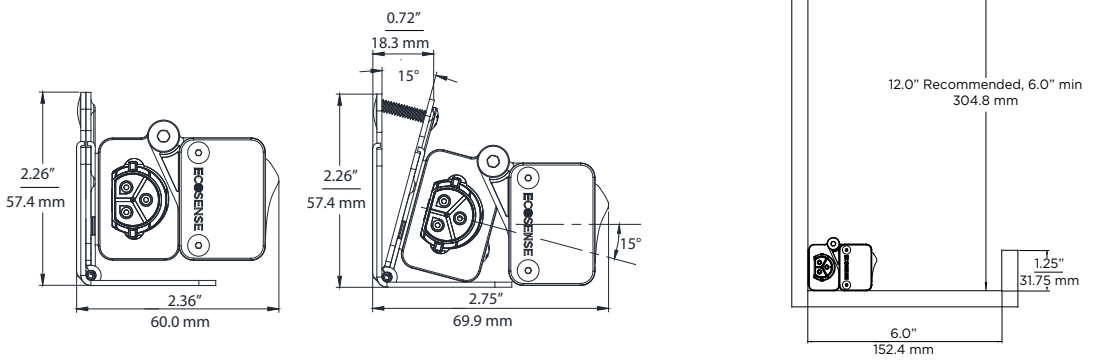
Wire Box

Conduit Connection, Wire Box, TROV, Interior Only, L50 .....CC-L-WIREBOX

Wire box can be used instead of a leader cable to start a run. 1/2" conduit fitting can attach directly to the box on one end and the fixture to the other.



Fine Adjustable L-Bracket:



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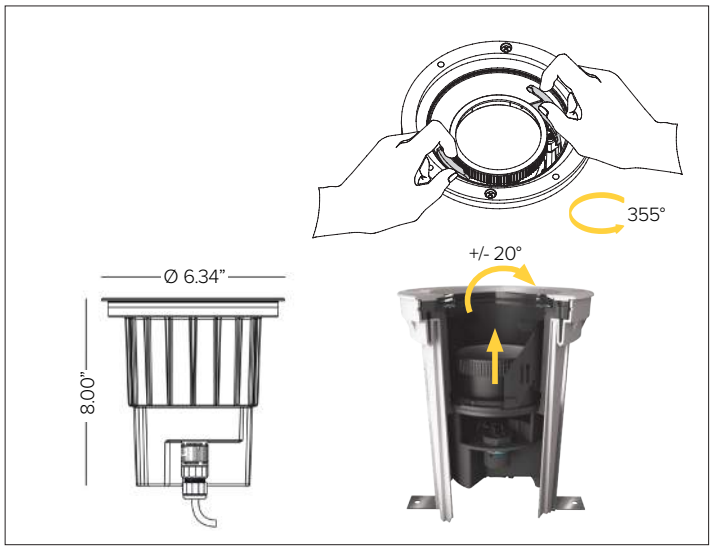
FREEDOM TO CREATE™

KEPLERO MINI ZOOM

Professional Inground LED Fixture

KEPLERO® MINI ZOOM with brushed natural trim and clear lens



QS | Marine[A] | RoHS3 Compliant | Drive Over | Cool Touch | IP69K | IP68 | c UL us

CONCEPT

Professional fully adjustable landscape inground fixture. As landscaping matures and changes overtime the zoom optic can be manually adjusted to adapt with the ever changing landscape conditions.

MECHANICAL CHARACTERISTICS

Housing	8"H x 6.34"Dia. Housing.
Materials	Anodized marine grade cataphoresis[A] die-cast aluminum heat sink body with PVC installation sleeve. AISI316L stainless steel trim ring with beveled edge with extra clear glass lens.
Finish	Brushed Natural · Bronze PVD* · Black PVD*
	*Physical Vapor Deposition.
Power Connection	Provided with 4ft SJ00W 16-6 cable and DSMT anti-wicking quick disconnect to direct burial brass ingrade jbox (required, sold separately).
Functionality	Adjustable +/-20° on the vertical axis and rotated 355° on the horizontal axis with friction locking mechanism.
Mounting	Flush, semi-flush or raised tube mountings. Installation sleeve for flush or semi-flush mountings includes optional stainless steel 'L' brackets for additional mounting support. Fixture equipped with fastening holes and stainless steel screws for attachment into installation sleeve assembly.
Weight	2.43lbs
Protection	IP68[B] / IP69K
Impact	IK10
Load	Resistant to static loads up to 4,496lbs in flush mounted cement and pavement installations.

CERTIFICATIONS

cULus Class2 Wet Location Listed.
Tested in accordance with LM-79-08.
Compliant for California installations.
IEC 62471
RoHS3 EU 215/863

SUSTAINABILITY

Luminaire designed for disposal/recycling at end-of-life. Replaceable LED light source and control gear by a Targetti technician.

ELECTRICAL CHARACTERISTICS

Power Supply	Integral 4/1 smart driver (Non-Dimmable / 0-10V / Reverse Phase / Forward Phase).
Wattage	14W
Voltage	Universal Voltage 120-277V AC 50/60Hz
Ambient Temp.	-25°C / +35°C (95°F)

SOURCE

High efficiency LED Chip on Board.

TM30	*CCT (Nominal)*	*CRI*	*Rf*	*Rg*	*SDCM*
	2700K	80	82	96	2
	3000K	80	83	96	2
	3500K	80	83	95	2
	4000K	80	82	95	2

Ra90 available upon request

OPTIC

Zoom optical system manually slides and locks on vertical axis collimating the optic to four different fixed beam positions (SP / FL / MWFL / WFL).

Beam		*SP 15°*	*FL 32°*	*MWFL 53°*	*WFL 61°*
Delivered Lumens	***2700K***	627Lm	831Lm	1,073Lm	1,158Lm
	3000K	661Lm	876Lm	1,132Lm	1,221Lm
	4000K	669Lm	887Lm	1,146Lm	1,236Lm

For 3500K lumen values use multiplier of 1.01 from 3000K.

Efficacy	95Lm/W max. Refer to photometric graphs for specific values.
Lifetime	L95/B10 30,000hrs at max TA +25°C L94/B10 50,000hrs at max TA +25°C
Photobiological Classification	Low risk safety RG1

WARRANTY

5 year limited warranty.

[A] Fixture body complete with marine grade cataphoresis suitable for use in marine grade environments. Stainless steel trim will need to be maintained and cleaned regularly to avoid mineral deposits. Not to be in direct contact with salt or corrosive agents for extended periods of time.

[B] Temporary immersion up to 24 hours at a max depth of 2 meters. Installation of fixture requires proper drainage to prevent any standing water. Should not be used for permanent submersion.

KEPLERO MINI ZOOM

SPECIFICATION INFORMATION

KPLM	41	ZM			/	/	/	/
1	2	3	4	5	6	7	8	9

Ex: KPLM41ZML227 / 1E2525 / 1DU2521 / 1DU2530

REQUIRED — OPTIONAL

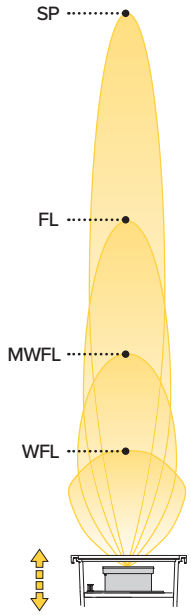
1 - PRODUCT CODE	2 - DRIVER	3 - TYPE	4 - WATTAGE	5 - KELVIN
KPLM — KEPLERO MINI	**41** – 4/1 Smart Dimming *(Non-Dimming / 0-10V / Reverse Phase / Forward Phase)*	**ZM** – Zoom	**L2** — 14W	**27** — 2700K **30** — 3000K **35** — 3500K **40** — 4000K

6 - TRIM	7 - INSTALLATION	8 - INSTALLATION ACCESSORIES	9 - OPTICAL ACCESSORIES
Round Trim Ring *See section for details*	Flush Mount Sleeve *See section for details*	Torx Key *See section for details*	Blade of Light Linear Spread Lens *See section for details*
Square Trim Ring *See section for details*	Raised Tube *See section for details*	Fixture Removal Tool *See section for details*	Anti Glare Honeycomb Louver *See section for details*
	Junction Box *See section for details*	Glass Removal Tool *See section for details*	Half Moon Anti Glare Shutter *See section for details*

For applicable quick ship items, see model configurations listed below. Lead time for quick ship fixtures is 1-2 weeks from processed PO date. Consult factory for quantities of over 20pcs to confirm lead time.

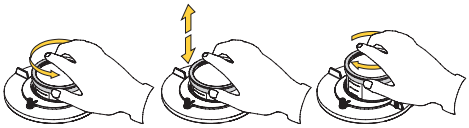
QS **QSKPLM41ZML230 + 1E2525 + 1DU2521 + 1DU2530**

OPTICAL SYSTEM



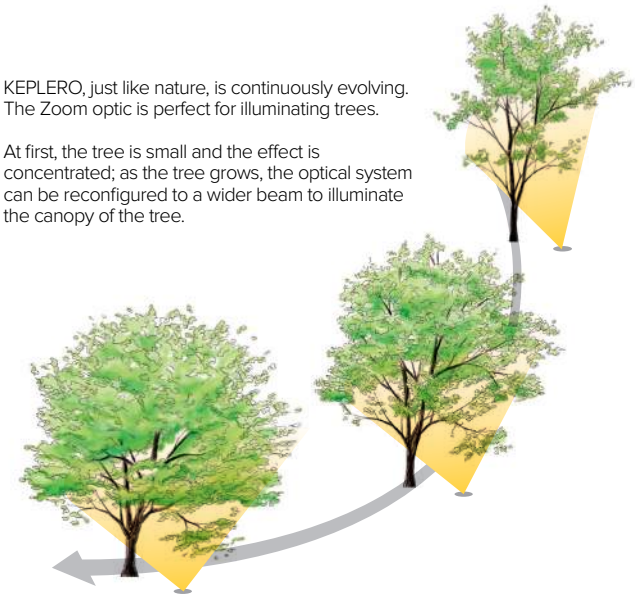
Zoom is a patented optical system that allows variation of the beam opening by manually moving the optical chamber.

Three simple movements - extraction, translation and rotation - it is possible to vary the beam opening from SP to WFL. Graduated rings help to recognize the adjustment allowing for easy repetition.



KEPLERO, just like nature, is continuously evolving. The Zoom optic is perfect for illuminating trees.

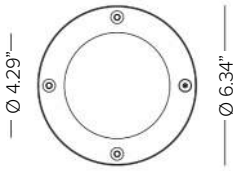
At first, the tree is small and the effect is concentrated; as the tree grows, the optical system can be reconfigured to a wider beam to illuminate the canopy of the tree.



KEPLERO MINI ZOOM

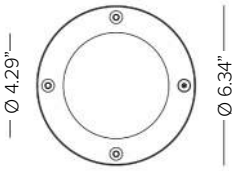
6 - TRIM (REQUIRED)

ROUND TRIM RING



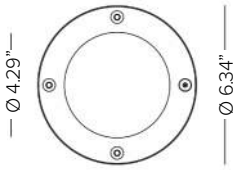
Round stainless steel (AISI316L) decorative ring. 10mm thick extra clear protective glass. Silicone gasket. Tamper proof (AISI316L) Torx screws.

Finish	Brushed Natural	Bronze PVD	Black PVD
Part No.	**1E2525**	**1DU2525B**	**1DU2525K**



Round stainless steel (AISI316L) decorative ring with anti-slip glass. 10mm thick extra clear protective glass. Silicone gasket. Tamper proof (AISI316L) Torx screws.

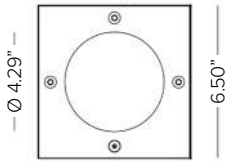
Finish	Brushed Natural	Bronze PVD	Black PVD
Part No.	**1DU2525A**	**1DU2525BA**	**1DU2525KA**



Round stainless steel (AISI316L) decorative ring with half frosted glass. 10mm thick extra clear protective glass. Silicone gasket. Tamper proof (AISI316L) Torx screws.

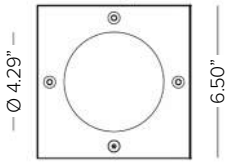
Finish	Brushed Natural	Bronze PVD	Black PVD
Part No.	**1DU2525E**	**1DU2525BE**	**1DU2525KE**

SQUARE TRIM RING



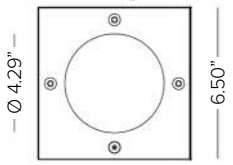
Square stainless steel (AISI316L) decorative ring. 10mm thick extra clear protective glass. Silicone gasket. Tamper proof (AISI316L) Torx screws.

Finish	Brushed Natural
Part No.	**1E2526**



Square stainless steel (AISI316L) decorative ring. 10mm thick extra clear protective glass. Silicone gasket. Tamper proof (AISI316L) Torx screws.

Finish	Brushed Natural
Part No.	**1DU2526A**

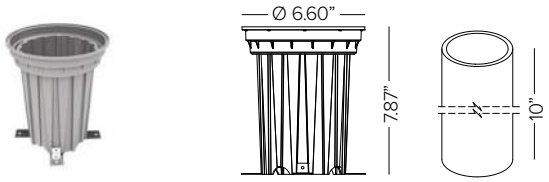


Square stainless steel (AISI316L) decorative ring. 10mm thick extra clear protective glass. Silicone gasket. Tamper proof (AISI316L) Torx screws.

Finish	Brushed Natural
Part No.	**1DU2526E**

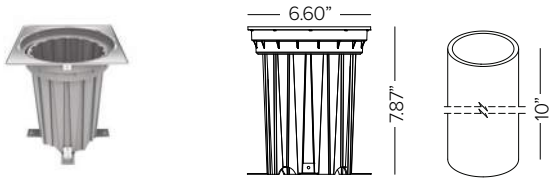
KEPLERO MINI ZOOM

7 - INSTALLATION (REQUIRED)



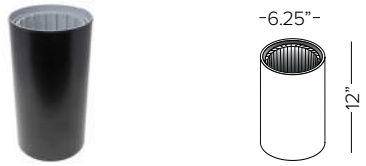
Installation sleeve for concrete pour applications. Grey Nylon casing with PVC installation outer pipe. For flush or semi-flush installations. **Required for use with 1DU2530 by NEC.**

Part No. **1DU2521**



Installation sleeve for concrete pour applications. Grey Nylon casing and stainless steel profile with PVC installation outer pipe. Square ring for flush installation only. **For use with square trim options only. Required for use with 1DU2530 by NEC.**

Part No. **1DU2522**



At grade or raised installation sleeve for turf or ground cover applications. 12”H stainless steel, includes factory pre-installed inner PVC installation sleeve. **To be used with round trim options only. Not suitable for use with 1DU2521 or 1DU2522.** (Field cuttable. Used for fixture elevations at grade to 3” above grade). **Required for use with 1DU2530 by NEC.**

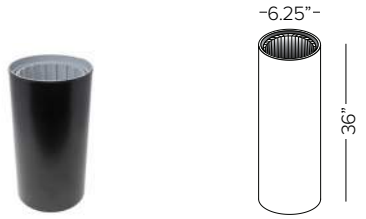
Finish ● Deep Black

Part No. **1DU4344-12**

Raised installation sleeve for ground cover (succulents and low level planting) applications. 18”H stainless steel, includes factory pre-installed inner PVC sleeve. **To be used with round trim options. Not suitable with 1DU2521 or 1DU2522.** (Field cuttable. Used for fixture elevation 7” above grade). **Required for use with 1DU2530 by NEC.**

Finish ● Deep Black

Part No. **1DU4344-18**



Raised installation sleeve for landscape applications. 36”H stainless steel, includes factory pre-installed inner PVC sleeve. **To be used with round trim options. Not suitable with 1DU2521 or 1DU2522.** (Field cuttable. Used for fixture elevation 21” above grade). **Required for use with 1DU2530 by NEC.**

Finish ● Deep Black

Part No. **1DU4344**

Direct burial brass ingrade j-box. Features stainless steel cover screws and strain relief for power cord, (2) 3/4” NPT bottom holes and (2) 3/4” NPT side holes. Includes (4) 3/4” to 1/2” adapters and (2) 1/2” NPT plugs. **(REQUIRED by NEC).**

Part No. **1DU2530**

8 - INSTALLATION (OPTIONAL)

Fixture metal maintenance removal handle. Helpful one per 10 fixtures.

Part No. **1E2524**

Anti-vandal torx head. Helpful one per 5 fixtures.

Part No. **1E2495**

Glass suction removal tool. Helpful one per 20 fixtures.

Part No. **1E0388**

KEPLERO MINI ZOOM

9 - OPTICAL ACCESSORIES (OPTIONAL)

MAXIMUM OF ONE OPTICAL FILTER OR LOUVER ACCESSORY PER FIXTURE

'Blade of Light' linear spread lens. Parallel ribbed glass.

Part No. **1T1708**

Anti-glare honeycomb louver with lacquered metal structure.

Finish ● Deep Black

Part No. **1T1711**

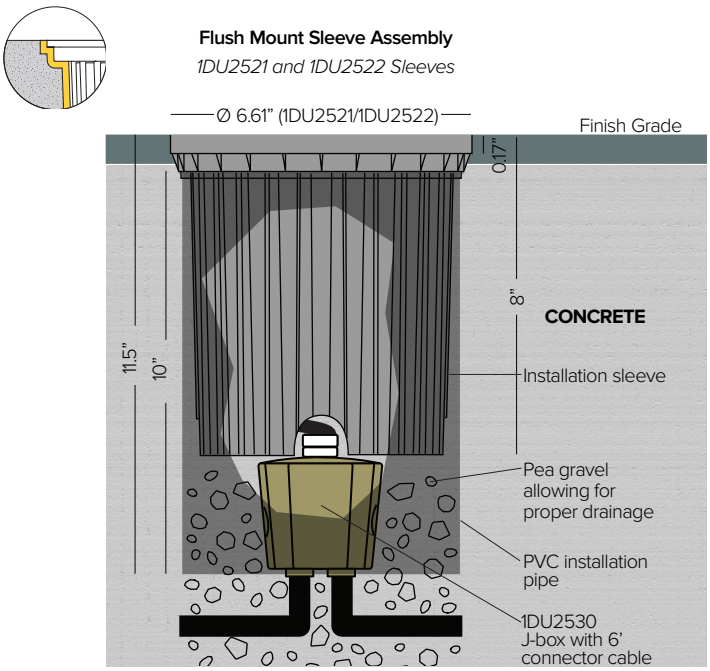
Integral half moon anti glare shutter. **Can be used as one per fixture with a filter or louver, not considered as part of the maximum optical accessories.**

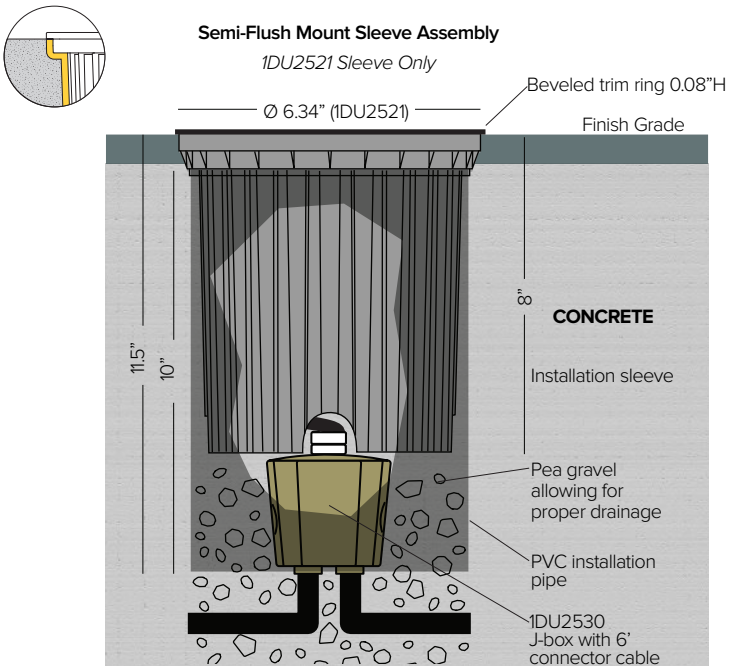
Finish ● Deep Black

Part No. **1E2523**

INSTALLATION DIAGRAM

CONCRETE POUR APPLICATION





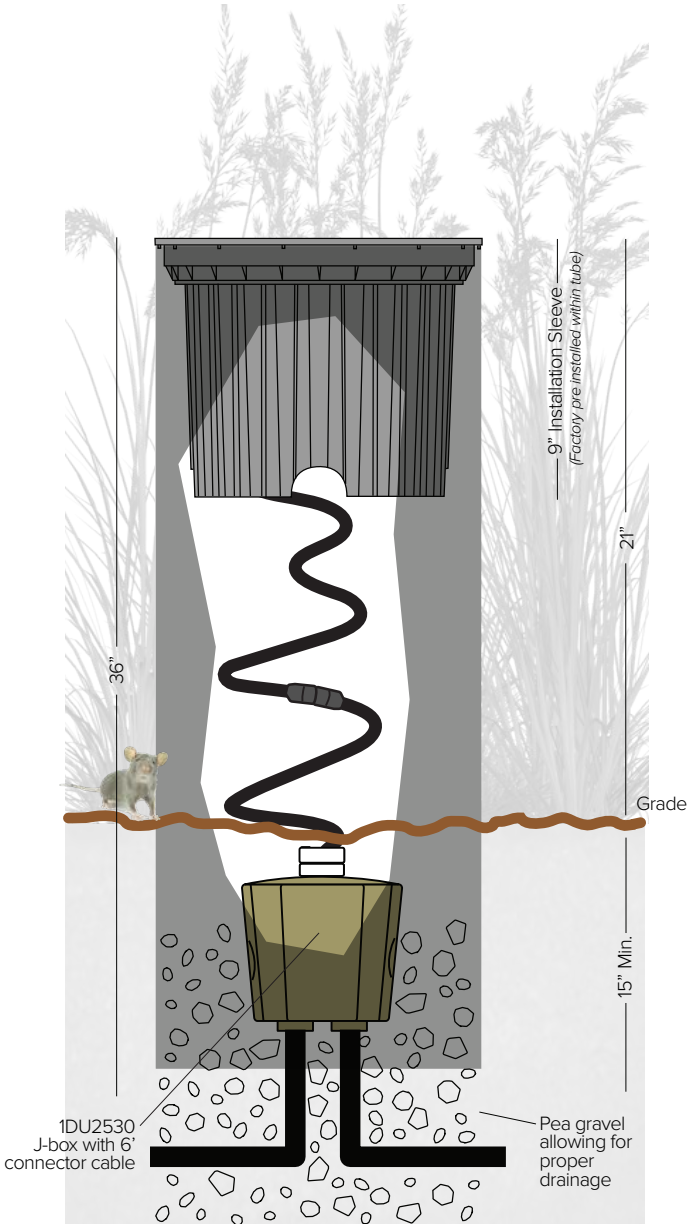
KEPLERO MINI ZOOM

INSTALLATION DIAGRAM

LANDSCAPE APPLICATION

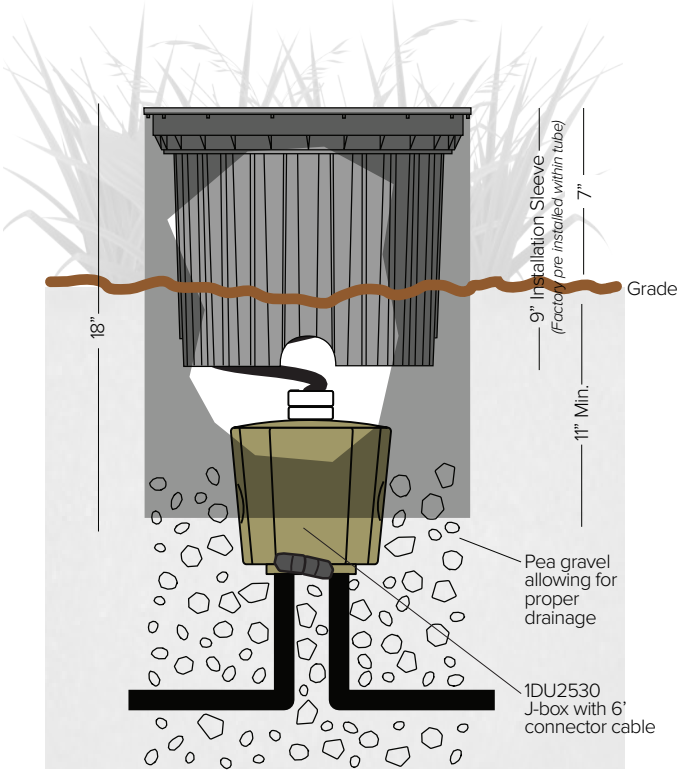
RAISED TUBE INSTALLATION ASSEMBLY

Recommended for Landscape Installation
1DU4344 with Round Trim ONLY



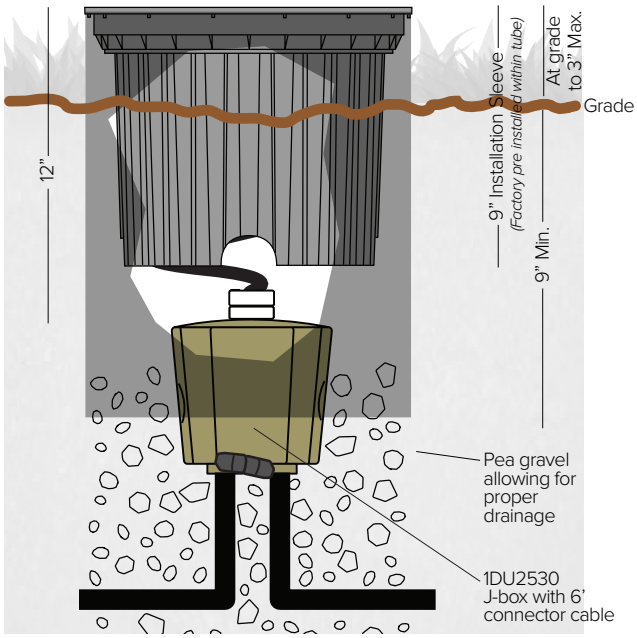
RAISED TUBE INSTALLATION ASSEMBLY

Recommended for Ground Level Installation
1DU434418 with Round Trim ONLY



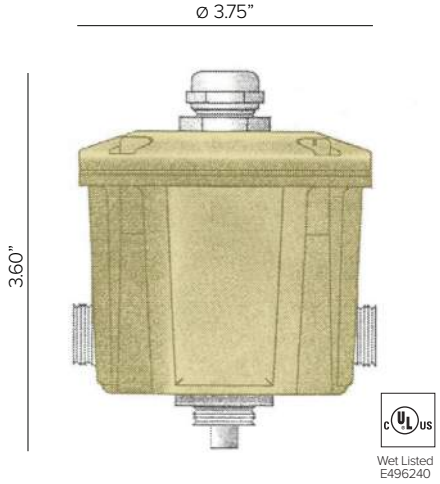
RAISED TUBE INSTALLATION ASSEMBLY

Recommended for Turf Installation
1DU434412 with Round Trim ONLY



KEPLERO MINI ZOOM

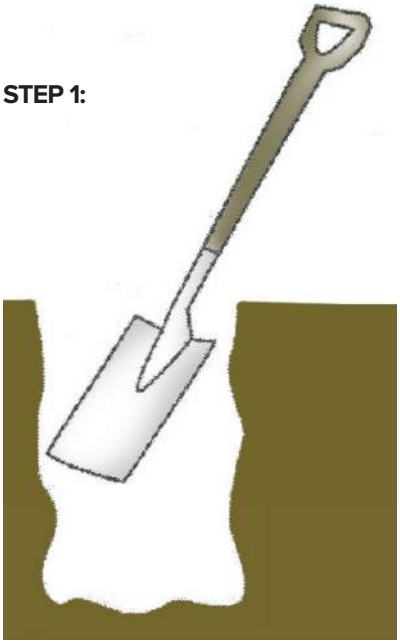
INSTALLATION DIAGRAM - 1DU2530 J-Box



Brass junction box is supplied with the following components:
(4) ¾” side/bottom NPT holes
(4) ½” reduction NPT adapters
(2) ½” cap plugs

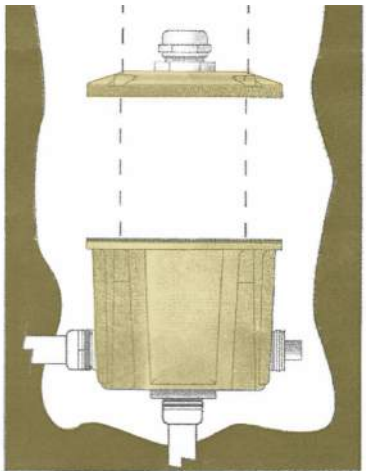
NOTE: Box fill size = 15.94 IN^3

STEP 1:



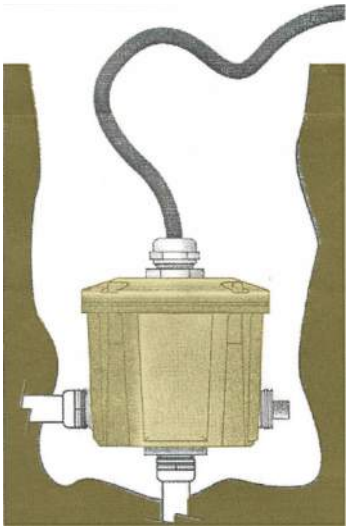
Dig a hole large enough to accommodate the junction box.

STEP 2:



Connect brass junction box to conduit system. Seal conduit entries inside junction box with a good grade RTV sealant per sealant manufacturer’s instructions.
Note: Drainage must be in place below junction box.

STEP 3:

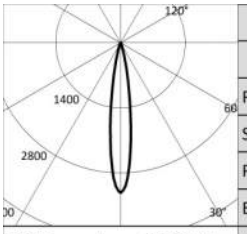


Seal threads. Tighten locking screw on bottom of cover. Connect all wires observing polarity (i.e. green-to-ground, white-to-common, and black-to-voltage). Provided with 1/2” strain relief.

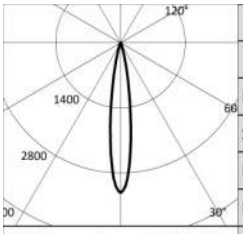
KEPLERO MINI ZOOM

PHOTOMETRY

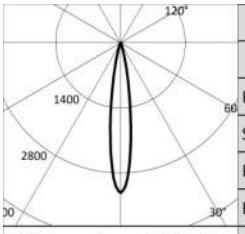
SPOT



2700K		H(m)	D(m)	Emax(lx)
Ra80			15°	
Fixture Power	14W	1	0.27	5870
Source Flux	1823lm	2	0.54	1467
Fixture Flux	627lm	3	0.82	652
Efficacy	46lm/W	4	1.09	367
TS815 Imax=3220cd/klm	Imax	5870cd	5	1.36	235

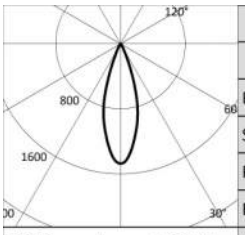


3000K		H(m)	D(m)	Emax(lx)
Ra80			15°	
Fixture Power	13W	1	0.27	6192
Source Flux	1923lm	2	0.54	1548
Fixture Flux	661lm	3	0.82	688
Efficacy	49lm/W	4	1.09	387
TS815 Imax=3220cd/klm	Imax	6192cd	5	1.36	248

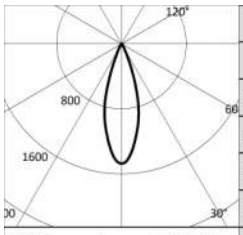


4000K		H(m)	D(m)	Emax(lx)
Ra80			15°	
Fixture Power	13W	1	0.27	6266
Source Flux	1946lm	2	0.54	1566
Fixture Flux	669lm	3	0.82	696
Efficacy	51lm/W	4	1.09	392
TS815 Imax=3220cd/klm	Imax	6266cd	5	1.36	251

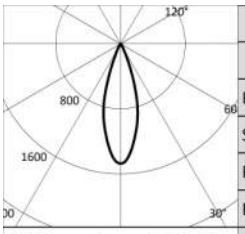
FLOOD



2700K		H(m)	D(m)	Emax(lx)
Ra80			32°	
Fixture Power	14W	1	0.58	2678
Source Flux	1823lm	2	1.15	670
Fixture Flux	831lm	3	1.73	298
Efficacy	61lm/W	4	2.30	167
TS816 Imax=1469cd/klm	Imax	2678cd	5	2.88	107



3000K		H(m)	D(m)	Emax(lx)
Ra80			32°	
Fixture Power	13W	1	0.58	2825
Source Flux	1923lm	2	1.15	706
Fixture Flux	876lm	3	1.73	314
Efficacy	65lm/W	4	2.30	177
TS816 Imax=1469cd/klm	Imax	2825cd	5	2.88	113

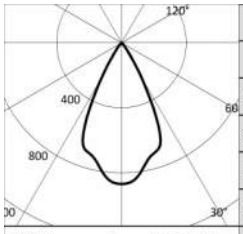


4000K		H(m)	D(m)	Emax(lx)
Ra80			32°	
Fixture Power	13W	1	0.58	2859
Source Flux	1946lm	2	1.15	715
Fixture Flux	887lm	3	1.73	318
Efficacy	68lm/W	4	2.30	179
TS816 Imax=1469cd/klm	Imax	2859cd	5	2.88	114

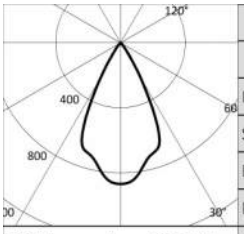
KEPLERO MINI ZOOM

PHOTOMETRY

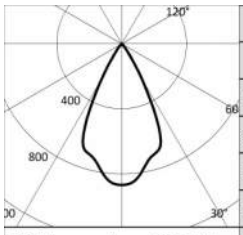
MEDIUM WIDE FLOOD



2700K		H(m)	D(m)	Emax(lx)
Ra80			53°	
Fixture Power	14W	1	0.99	1578
Source Flux	1823lm	2	1.98	394
Fixture Flux	1073lm	3	2.97	175
Efficacy	78lm/W	4	3.95	99
TS817 Imax=866cd/klm	Imax 1578cd	5	4.94	63

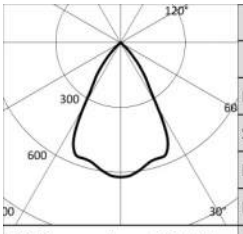


3000K		H(m)	D(m)	Emax(lx)
Ra80			53°	
Fixture Power	13W	1	0.99	1664
Source Flux	1923lm	2	1.98	416
Fixture Flux	1132lm	3	2.97	185
Efficacy	84lm/W	4	3.95	104
TS817 Imax=866cd/klm	Imax 1664cd	5	4.94	67

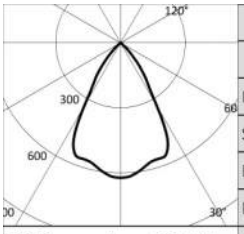


4000K		H(m)	D(m)	Emax(lx)
Ra80			53°	
Fixture Power	13W	1	0.99	1684
Source Flux	1946lm	2	1.98	421
Fixture Flux	1146lm	3	2.97	187
Efficacy	88lm/W	4	3.95	105
TS817 Imax=866cd/klm	Imax 1684cd	5	4.94	67

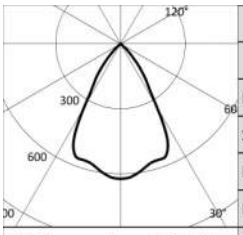
WIDE FLOOD



2700K		H(m)	D(m)	Emax(lx)
Ra80			61°	
Fixture Power	14W	1	1.18	1132
Source Flux	1823lm	2	2.37	283
Fixture Flux	1158lm	3	3.55	126
Efficacy	85lm/W	4	4.74	71
TS818 Imax=621cd/klm	Imax 1132cd	5	5.92	45



3000K		H(m)	D(m)	Emax(lx)
Ra80			61°	
Fixture Power	13W	1	1.18	1194
Source Flux	1923lm	2	2.37	299
Fixture Flux	1221lm	3	3.55	133
Efficacy	91lm/W	4	4.74	75
TS818 Imax=621cd/klm	Imax 1194cd	5	5.92	48



4000K		H(m)	D(m)	Emax(lx)
Ra80			61°	
Fixture Power	13W	1	1.18	1208
Source Flux	1946lm	2	2.37	302
Fixture Flux	1236lm	3	3.55	134
Efficacy	95lm/W	4	4.74	76
TS818 Imax=621cd/klm	Imax 1208cd	5	5.92	48

insight lighting

SMART SIGN 2.0

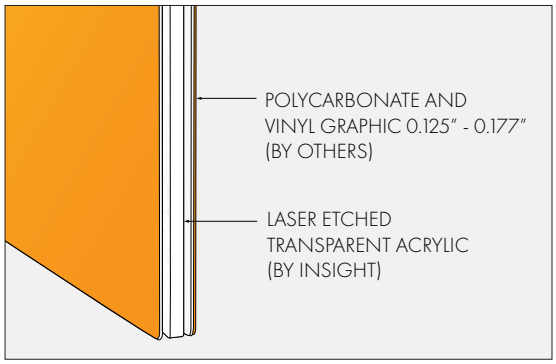
EDGE-LIT WAYFINDING SYSTEMS

PROJECT: TYPE: CAT. #: PRS2 - 8 - 50K - - - - - - -

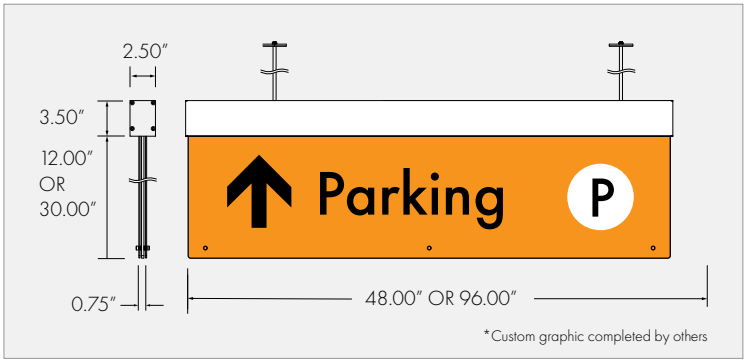
PROFILE

LIGHT SOURCE	8.0 W/FT
CCT	5000K
CRI	80 (± 200)
VOLTAGE	UNIVERSAL 120-277V
POWER	INTEGRATED POWER SUPPLY
CONTROL	0-10V DIMMING, SINK
DIMENSIONS	12" – 30" HEIGHT X 24" – 96" LENGTH
WEIGHT	4.375 LBS/FT2
HOUSING	UPPER ALUMINUM EXTRUSION
OPTICAL SYSTEMS	TRANSPARENT CAST ACRYLIC 6 MM THICKNESS, LASER ETCHED
FINISH	HIGH DURABILITY POWDER COATING
WARRANTY	5-YEAR LIMITED
OPERATING TEMP	-25° C TO 40° C
LUMEN MAINTENANCE	75,000 HOURS L70
CERTIFICATION	UL 48 STANDARDS, COMPLIES WITH BUILD AMERICA, BUY AMERICA
US PATENT	US9,709,227 B2

SIMPLE GRAPHIC INSTALLATION (BY OTHERS)



PROFILE



PERFORMANCE SAMPLE

48.00"	UNIFORMITY	LUMINANCE
8.0 W/FT	1.4:1	500 CD/M²

ACCESSORIES / OPTIONS

EDGE DIFFUSER

insight lighting
4341 Fulcrum Way NE, Rio Rancho New Mexico 87144
P.: 505.345.0888 | **insightlighting.com**

PROJECT: TYPE: CAT. #: PRS2 - 8 - 50K - - - - - - -

SPECIFICATION

PRS2	8	50K						
1	2	3	4	5	6	7	8	9

1 FIXTURE

SMART SIGN 2.0	PRS2

2 WATTAGE

8.0 W/FT	8

3 CCT

5000K	50K

4 MOUNTING

SURFACE/CEILING	SMS
PENDANT	PNS
SUSPENDED ALL THREAD	SAT
FLAG WALL MOUNT	FLW

contact factory for Flag Wall Mount

5 NOMINAL FIXTURE LENGTH

48.00" X 12.00"	4812
48.00" X 24.00"	4824
48.00" X 36.00"	4836
96.00" X 12.00"	9612
96.00" X 24.00"	9624
96.00" X 30.00"	9630

Additional sizes are available.
For custom sizes and mounting please contact factory
Acrylic sizes exceeding 24" require additional standoffs for support

6 VOLTAGE

120V	120
277V	277

7 CONTROL

NON-DIMMING	NO
0-10V DIMMING SINK	DIM

Dimming control system to be supplied by others

8 FINISH

SEMI-GLOSS WHITE	W
SEMI-GLOSS BLACK	BL
SEMI-GLOSS NATURAL	N
SEMI-GLOSS BRONZE	BR
SEMI-GLOSS SATIN	S
CUSTOM COLOR	CC

Contact factory for custom color - additional charges will apply

9 OPTIONS

EDGE DIFFUSER	ED

Edge diffuser reduces 80% of the brightness on the panel edge only
Does not reduce the brightness on the panel face
Best for direct view applications

CONTINUOUS RUN	CR

FIXTURES PER CIRCUIT

	8 WATTS/FT	
LENGTH	120V	277V
48"	30	72
96"	15	34

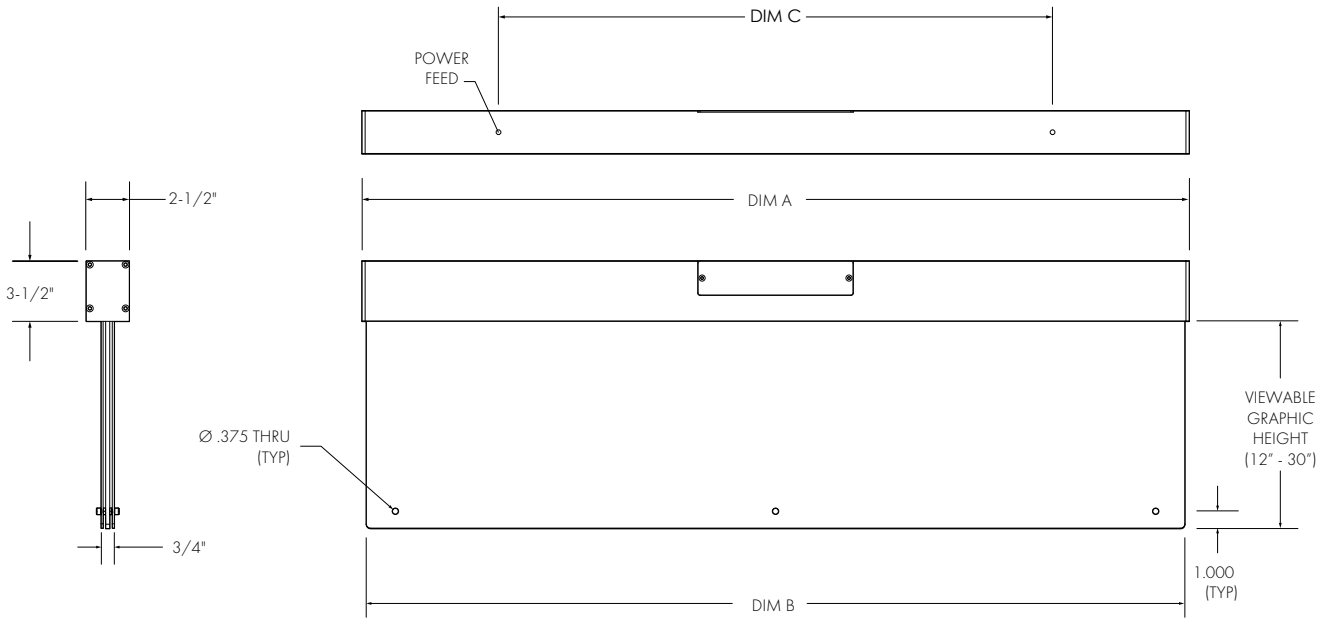
insight lighting
4341 Fulcrum Way NE, Rio Rancho New Mexico 87144
P.: 505.345.0888 | insightlighting.com

PROJECT: TYPE: CAT. #: PRS2 - 8 - 50K - - - - - - -

DIMENSIONS

NOM LENGTH	DIM A	DIM B	DIM C
24"	24.37"	23.87"	14.00"
36"	36.12"	35.62"	20.31"
48"	47.87"	47.37"	32.00"
60"	59.62"	59.12"	43.81"
72"	71.37"	70.87"	55.56"
84"	83.12"	82.62"	67.312"
96"	94.87"	94.37"	79.00"

SURFACE/CEILING (SMS) DISCONNECT SWITCH INCLUDED ON EVERY PRODUCT



insight lighting
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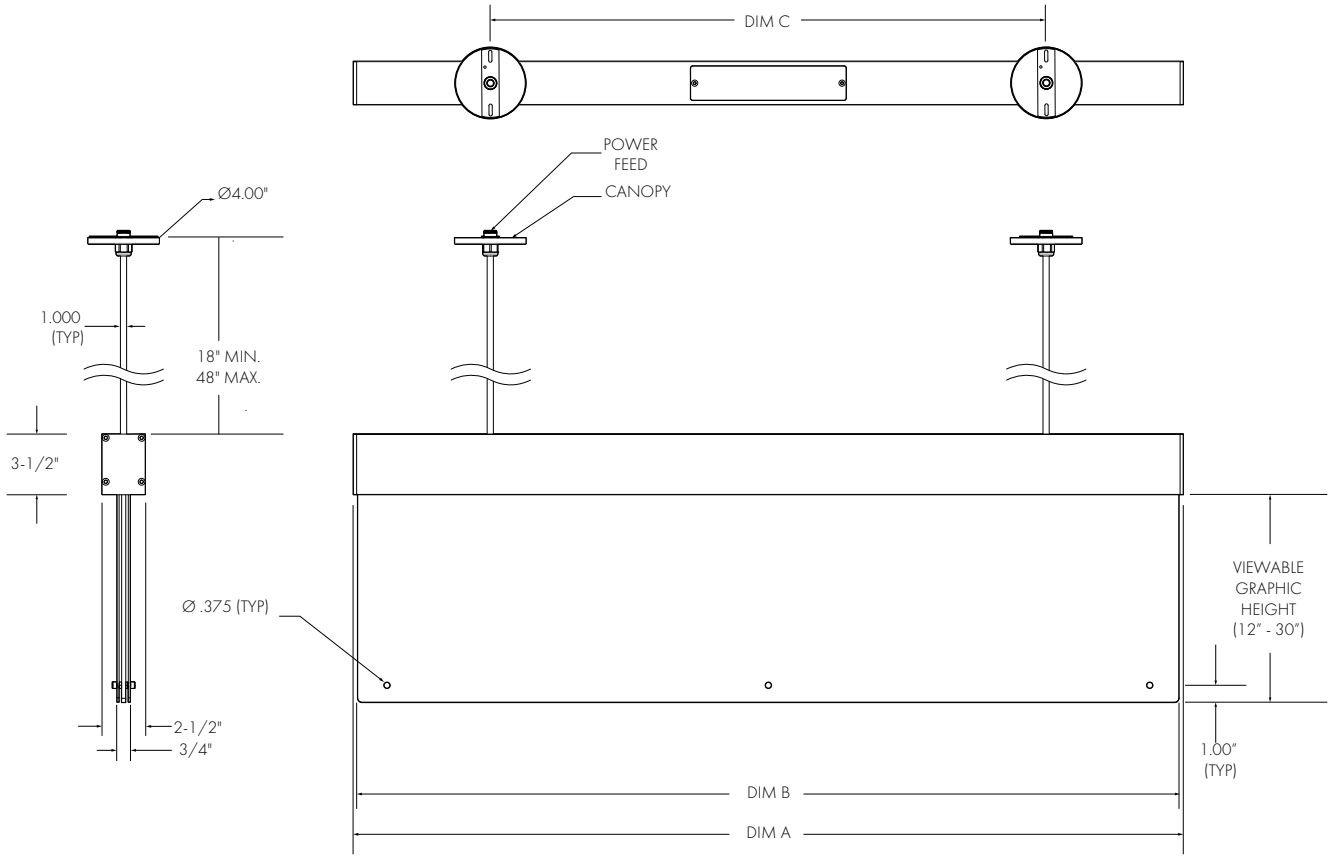
P.: 505.345.0888 | insightlighting.com

PROJECT: TYPE: CAT. #: PRS2 - 8 - 50K - - - - - - -

DIMENSIONS

NOM LENGTH	DIM A	DIM B	DIM C
24"	24.37"	23.87"	14.00"
36"	36.12"	35.62"	20.31"
48"	47.87"	47.37"	32.00"
60"	59.62"	59.12"	43.81"
72"	71.37"	70.87"	55.56"
84"	83.12"	82.62"	67.312"
96"	94.87"	94.37"	79.00"

PENDANT (PNS) DISCONNECT SWITCH INCLUDED ON EVERY PRODUCT



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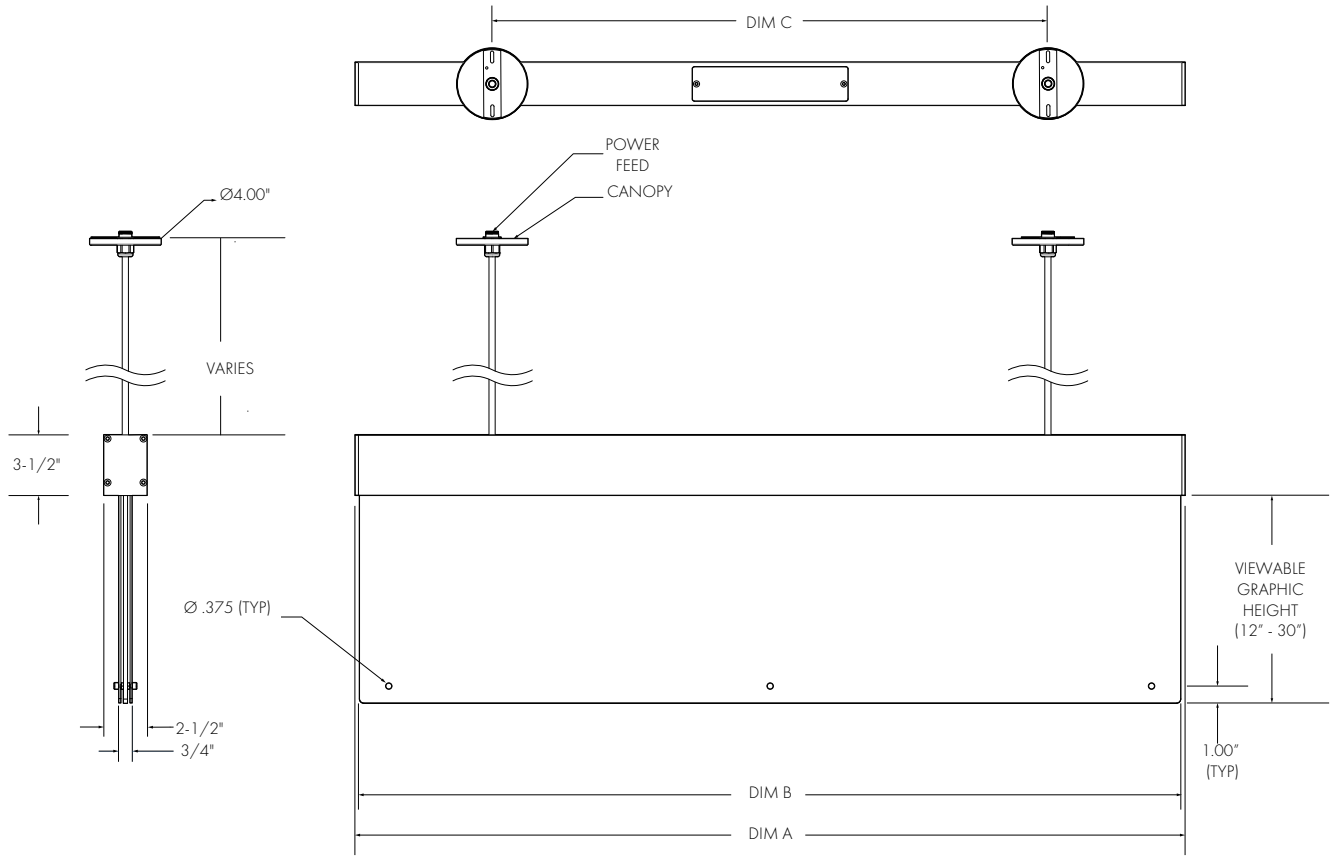
PROJECT: TYPE: CAT. #: PRS2 - 8 - 50K - - - - - - -

DIMENSIONS

NOM LENGTH	DIM A	DIM B	DIM C
24"	24.37"	23.87"	14.00"
36"	36.12"	35.62"	20.31"
48"	47.87"	47.37"	32.00"
60"	59.62"	59.12"	43.81"
72"	71.37"	70.87"	55.56"
84"	83.12"	82.62"	67.312"
96"	94.87"	94.37"	79.00"

SUSPENDED ALL THREAD (SAT) DISCONNECT SWITCH INCLUDED ON EVERY PRODUCT



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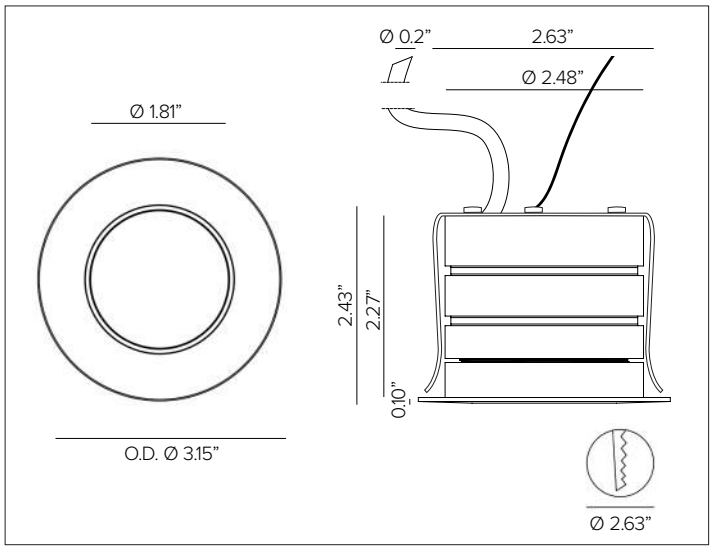
P.: 505.345.0888 | insightlighting.com

JUPITER DOWNLIGHT

Professional LED Downlight

JUPITER Shown in brushed natural finish.



RoHS3 Compliant | Marine[A] | IP69K | IP68 | cULus Class2

CONCEPT

Small scale compact recessed ingrade LED fixture for use in exterior or interior applications.

MECHANICAL CHARACTERISTICS

Housing	3.15”Dia. X 2.43”H
Materials	Milled anodized aluminum marine grade cataphoresis[A] body with Passive cooling system. AISI316L stainless steel trim ring with beveled edge and with extra clear glass lens. Stainless steel recessed spring clips for ceiling mounting and 24”L stainless steel tether cable.
Finish	Brushed Natural · Bronze PVD* · Black PVD* *Physical Vapor Deposition.
Power Connection	Pre-cabled with 2ft direct burial 18ga 2 conductor cable for connection to remote power supply.
Mounting	Semi-flush recessed downlight suitable for Class 2 installations for exterior or interior applications with ceiling thicknesses of 1/8” min. Not recommended for concrete ceilings, refer to ingrade version for this type of installation.
Weight	1.1lbs
Protection	IP68 / IP69K
Impact	IK10

CERTIFICATIONS

cULus Class 2 Wet Location Listed E479873.
Tested in accordance with LM-79-08.
Compliant for California installations.
RoHS3 EU 215/863

WARRANTY

5 year limited warranty

[A] Fixture body complete with marine grade cataphoresis suitable for use in marine grade environments. Stainless steel trim will need to be maintained and cleaned regularly to avoid mineral deposits. Not to be in direct contact with salt or corrosive agents for extended periods of time.

[B] Temporary immersion up to 24 hours. Installation of fixture requires proper drainage to prevent any standing water. Should not be used for permanent submersion.

SUSTAINABILITY

Luminaire designed for disposal/recycling at end-of-life. Replaceable LED light source and control gear by a Targetti technician.

ELECTRICAL CHARACTERISTICS

Power Supply	Remote Class 2 120V-277V AC power supply required, see available options.
Wattage	7W
Voltage	24V DC

SOURCE

High efficiency LED Chip on Board.

TM30	***CCT (Nominal)***	***CRI***	***Rf***	***Rg***	***SDCM***
	2700K	80	82	96	2
	3000K	80	83	96	2
	3500K	80	81	97	2
	4000K	80	82	95	2

Ra90 available upon request

OPTIC

Precision optic system with PMMA lenses for the SP, FL and WFL versions with a light cut system integrated into the front glass.

Beam		***SP 21º***	***FL 39º***	***WFL 53º***
Delivered Lumens	***2700K***	651Lm	674Lm	644Lm
Data represents max output version only, refer to photometry section for all fixture variations.	***3000K***	680Lm	704Lm	673Lm
	4000K	704Lm	728Lm	696Lm

For 3500K lumen values use multiplier of 1.015 from 3000K.

Efficacy	93Lm/W max. Refer to photometric graphs for specific values.
Lifetime	L96/B10 >30,000hrs at max Tq +25°C L93/B10 >50,000hrs at max Tq +25°C L90/B10 >80,000hrs at max Tq +25°C L87/B10 >100,000hrs at max Tq +25°C
Photobiological Classification	Low risk safety RG1

JUPITER DOWNLIGHT

SPECIFICATION INFORMATION

JUD								/
1	2	3	4	5	6	7	8	9
							OPTIONAL	REQUIRED

Ex: JUDRSPL22724SS / DMLE301242UD

1 - PRODUCT CODE	2 - DRIVER	3 - OPTIC	4 - WATTAGE	5 - KELVIN	6 - VOLTAGE	7 - TRIM	8 - OPTICAL ACCESSORY
JUD — JUPITER DOWNLIGHT	**R** — Remote Driver	**SP** — SP **FL** — FL **WF** — WFL	**L2** — 7W	**27** — 2700K **30** — 3000K **35** — 3500K **40** — 4000K	**24** — 24V DC	**SS** — Natural **BZ** — Bronze PVD **BK** — Black PVD	**__** — No Accessory **LV** [D] — Honeycomb Louver **AS** [D] — Asymmetric Louver

9 - POWER SUPPLY
Power Supply *See section for details*

[D] Optical accessories are factory pre-installed integral to the fixture.

FINISHES

BLACK PVD *BRONZE PVD* *NATURAL*

OPTIC VERSIONS

NO OPTIC ACCESSORY

INTEGRAL HONEYCOMB LOUVER

Optical accessory is factory pre-installed integral to the fixture.

INTEGRAL ASYMMETRIC LOUVER

Optical accessory is factory pre-installed integral to the fixture.

JUPITER DOWNLIGHT

9 - POWER SUPPLY (REQUIRED)

ENCLOSURE

Part No.	*Wattage*	*Control*	*Dim Range*	*Rating*	*In / Out Voltage*	*Certification*	*Dimensions (Enclosure)*	*Description*
DMLE301242UD	*30W*	MLV / ELV / 0-10V / TRIAC	1%	NEMA3R	120-277V / 24V	UL Class 2	4.47" X 6.79" X 1.38"	EMCOD MLE-UD electronic driver with wiring compartment.
DELV30124DJBX	*30W*	0-10V	10%	IP65	120-277V / 24V	UL Class 2	12.1" X 2.4" X 1.4"	Magnitude SOLIDrive electronic driver with built in junction box.
DMLE601242UD	*60W*	MLV / ELV / 0-10V / TRIAC	1%	NEMA3R	120-277V / 24V	UL Class 2	4.47" X 6.79" X 1.38"	EMCOD MLE-UD electronic driver with wiring compartment.
DELV60124DJBX	*60W*	0-10V	10%	IP65	120-277V / 24V	UL Class 2	12.1" X 2.4" X 1.4"	Magnitude SOLIDrive electronic driver with built in junction box.
DMLE961242UD	*96W*	MLV / ELV / 0-10V / TRIAC	1%	NEMA3R	120-277V / 24V	UL Class 2	5.16" X 7.73" X 1.54"	EMCOD MLE-UD electronic driver with wiring compartment.
DELV96124DJBX	*96W*	0-10V	10%	IP65	120-277V / 24V	UL Class 2	12.1" X 2.4" X 1.4"	Magnitude SOLIDrive electronic driver with built in junction box.
DMLE1922242UD	*2X96W*	MLV / ELV / 0-10V / TRIAC	1%	NEMA3R	120-277V / 24V	UL Class 2	5.04" X 10.94" X 1.81"	EMCOD MLE-UD electronic driver with wiring compartment.
DMLE2882242UD	*3X96W*	MLV / ELV / 0-10V / TRIAC	1%	NEMA3R	120-277V / 24V	UL Class 2	5.04" X 10.94" X 1.81"	EMCOD MLE-UD electronic driver with wiring compartment.

STANDALONE

Part No.	*Wattage*	*Control*	*Dim Range*	*Rating*	*In / Out Voltage*	*Certification*	*Dimensions (Standalone)*	*Description*
DELV30124D	*30W*	0-10V	10%	IP65	120-277V / 24V	UR Class 2	7.5" X 2.4" X 1.4"	Magnitude SOLIDrive electronic standalone driver. **UL listed enclosure provided by others.**
DELV60124D	*60W*	0-10V	10%	IP65	120-277V / 24V	UR Class 2	7.5" X 2.4" X 1.4"	Magnitude SOLIDrive electronic standalone driver. **UL listed enclosure provided by others.**
DELV96124D	*96W*	0-10V	10%	IP65	120-277V / 24V	UR Class 2	7.5" X 2.4" X 1.4"	Magnitude SOLIDrive electronic standalone driver. **UL listed enclosure provided by others.**

MAX FIXTURES PER DRIVER

Fixture Wattage	*Driver Wattage*				
	30W	*60W*	*96W*	*2 x 96W*	*3 x 96W*
7W	**3**	**6**	**10**	**10+10**	**10+10+10**

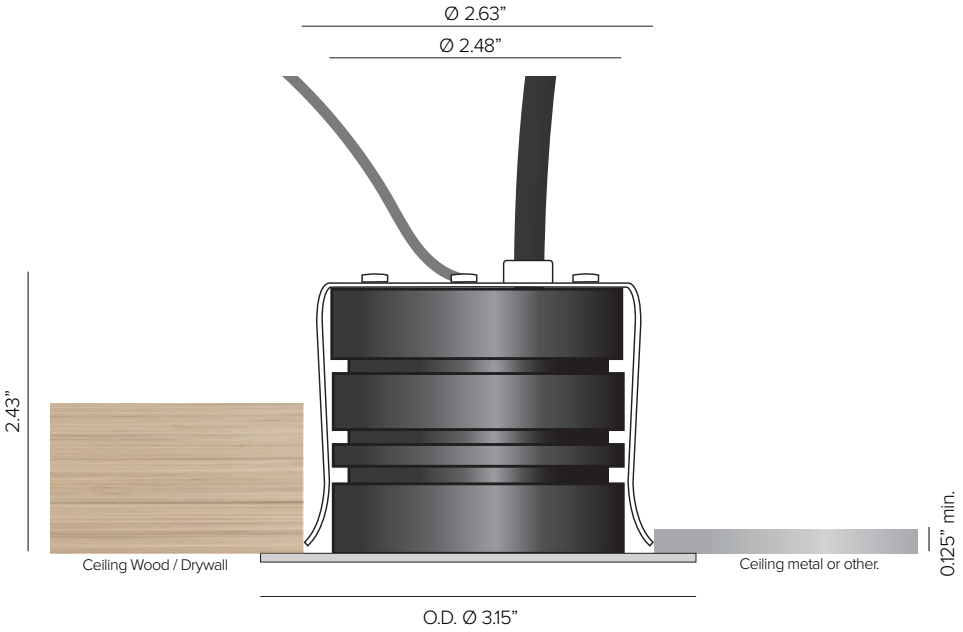
MAX CABLE DISTANCE

Fixture Wattage	*No. Fixtures*	*Load*	*18 AWG*	*16 AWG*	*14 AWG*	*12 AWG*
7W	**3**	**≤21W**	**55ft**	**85ft**	**140ft**	**220ft**
	6	**≤42W**	**31ft**	**50ft**	**80ft**	**125ft**
	8	**≤56W**	**23ft**	**37ft**	**60ft**	**100ft**
	10	**≤70W**	**19ft**	**30ft**	**48ft**	**75ft**

**Voltage drop calculations are based on 3% max drop to last fixture in run for load and distances below*

JUPITER DOWNLIGHT

INSTALLATION DIAGRAM

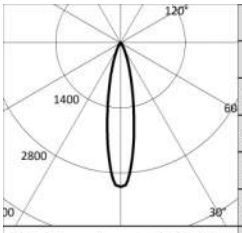


JUPITER DOWNLIGHT

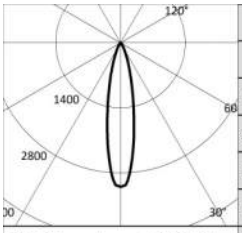
PHOTOMETRY

IES FILES WATTAGE AND EFFICIENCY CALCULATIONS BASED WITH SUPPLIED DRIVER

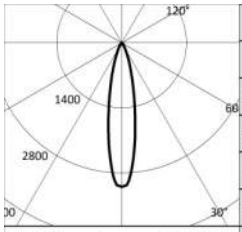
SPOT



2700K		H(m)	D(m)	Emax(lx)
Ra80			21°	
Fixture Power	7W	1	0.38	2861
Source Flux	926lm	2	0.75	715
Fixture Flux	651lm	3	1.13	318
Efficacy	96lm/W	4	1.50	179
TS1424 Imax=3090cd/klm	Imax	2861cd	5	1.88	114

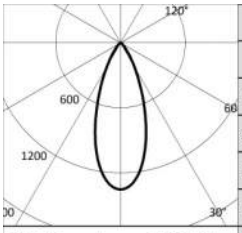


3000K		H(m)	D(m)	Emax(lx)
Ra80			21°	
Fixture Power	7W	1	0.38	2988
Source Flux	967lm	2	0.75	747
Fixture Flux	680lm	3	1.13	332
Efficacy	100lm/W	4	1.50	187
TS1424 Imax=3090cd/klm	Imax	2988cd	5	1.88	120

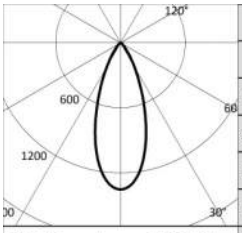


4000K		H(m)	D(m)	Emax(lx)
Ra80			21°	
Fixture Power	7W	1	0.38	3093
Source Flux	1001lm	2	0.75	773
Fixture Flux	704lm	3	1.13	344
Efficacy	104lm/W	4	1.50	193
TS1424 Imax=3090cd/klm	Imax	3093cd	5	1.88	124

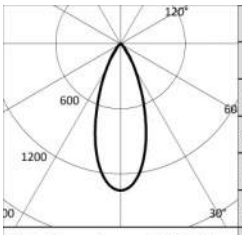
FLOOD



2700K		H(m)	D(m)	Emax(lx)
Ra80			39°	
Fixture Power	7W	1	0.71	1250
Source Flux	926lm	2	1.41	312
Fixture Flux	674lm	3	2.12	139
Efficacy	99lm/W	4	2.83	78
TS1425 Imax=1349cd/klm	Imax	1250cd	5	3.53	50

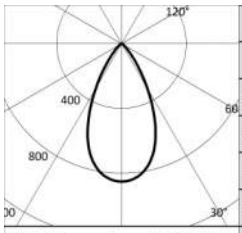


3000K		H(m)	D(m)	Emax(lx)
Ra80			39°	
Fixture Power	7W	1	0.71	1305
Source Flux	967lm	2	1.41	326
Fixture Flux	704lm	3	2.12	145
Efficacy	103lm/W	4	2.83	82
TS1425 Imax=1349cd/klm	Imax	1305cd	5	3.53	52

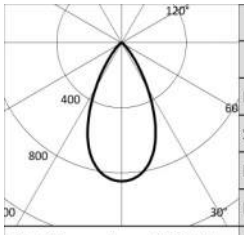


4000K		H(m)	D(m)	Emax(lx)
Ra80			39°	
Fixture Power	7W	1	0.71	1351
Source Flux	1001lm	2	1.41	338
Fixture Flux	728lm	3	2.12	150
Efficacy	107lm/W	4	2.83	84
TS1425 Imax=1349cd/klm	Imax	1351cd	5	3.53	54

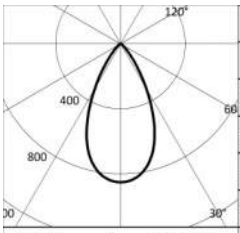
WIDE FLOOD



2700K		H(m)	D(m)	Emax(lx)
Ra80			53°	
Fixture Power	7W	1	0.99	787
Source Flux	926lm	2	1.99	197
Fixture Flux	644lm	3	2.98	87
Efficacy	95lm/W	4	3.98	49
TS1426 Imax=849cd/klm	Imax	787cd	5	4.97	31



3000K		H(m)	D(m)	Emax(lx)
Ra80			53°	
Fixture Power	7W	1	0.99	821
Source Flux	967lm	2	1.99	205
Fixture Flux	673lm	3	2.98	91
Efficacy	99lm/W	4	3.98	51
TS1426 Imax=849cd/klm	Imax	821cd	5	4.97	33



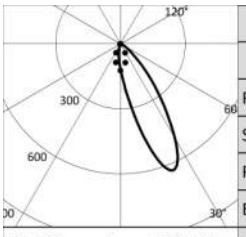
4000K		H(m)	D(m)	Emax(lx)
Ra80			53°	
Fixture Power	7W	1	0.99	850
Source Flux	1001lm	2	1.99	213
Fixture Flux	696lm	3	2.98	94
Efficacy	102lm/W	4	3.98	53
TS1426 Imax=849cd/klm	Imax	850cd	5	4.97	34

JUPITER DOWNLIGHT

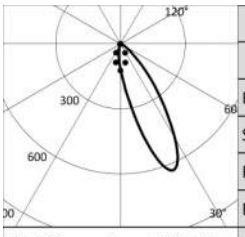
PHOTOMETRY

IES FILES WATTAGE AND EFFICIENCY CALCULATIONS BASED WITH SUPPLIED DRIVER

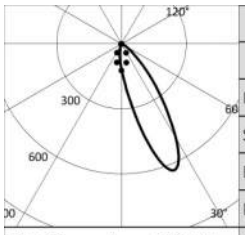
SPOT ASYMMETRIC LOUVER



2700K		H(m)	D1(m)	D2(m)	Emax(lx)
Ra80			26°	26°	
Fixture Power	7W	1	0.56	0.50	467
Source Flux	926lm	2	1.11	1.00	117
Fixture Flux	197lm	3	1.67	1.51	52
Efficacy	29lm/W	4	2.22	2.01	29
TS1430 Imax=628cd/klm	Imax 582cd	5	2.78	2.51	19

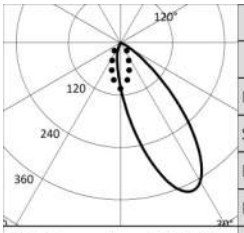


3000K		H(m)	D1(m)	D2(m)	Emax(lx)
Ra80			26°	26°	
Fixture Power	7W	1	0.56	0.50	488
Source Flux	967lm	2	1.11	1.00	122
Fixture Flux	205lm	3	1.67	1.51	54
Efficacy	30lm/W	4	2.22	2.01	30
TS1430 Imax=628cd/klm	Imax 607cd	5	2.78	2.51	20

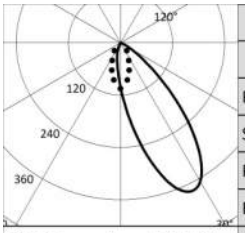


4000K		H(m)	D1(m)	D2(m)	Emax(lx)
Ra80			26°	26°	
Fixture Power	7W	1	0.56	0.50	505
Source Flux	1001lm	2	1.11	1.00	126
Fixture Flux	213lm	3	1.67	1.51	56
Efficacy	31lm/W	4	2.22	2.01	32
TS1430 Imax=628cd/klm	Imax 629cd	5	2.78	2.51	20

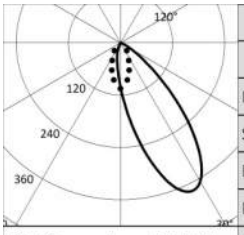
FLOOD ASYMMETRIC LOUVER



2700K		H(m)	D1(m)	D2(m)	Emax(lx)
Ra80			36°	41°	
Fixture Power	7W	1	0.82	0.82	268
Source Flux	926lm	2	1.64	1.64	67
Fixture Flux	189lm	3	2.46	2.46	30
Efficacy	28lm/W	4	3.29	3.29	17
TS1431 Imax=377cd/klm	Imax 349cd	5	4.11	4.11	11

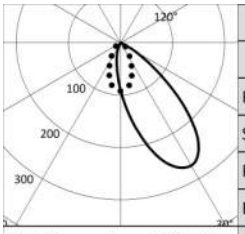


3000K		H(m)	D1(m)	D2(m)	Emax(lx)
Ra80			36°	41°	
Fixture Power	7W	1	0.82	0.82	279
Source Flux	967lm	2	1.64	1.64	70
Fixture Flux	197lm	3	2.46	2.46	31
Efficacy	29lm/W	4	3.29	3.29	17
TS1431 Imax=377cd/klm	Imax 365cd	5	4.11	4.11	11

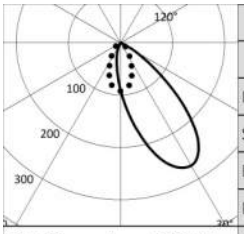


4000K		H(m)	D1(m)	D2(m)	Emax(lx)
Ra80			36°	41°	
Fixture Power	7W	1	0.82	0.82	289
Source Flux	1001lm	2	1.64	1.64	72
Fixture Flux	204lm	3	2.46	2.46	32
Efficacy	30lm/W	4	3.29	3.29	18
TS1431 Imax=377cd/klm	Imax 377cd	5	4.11	4.11	12

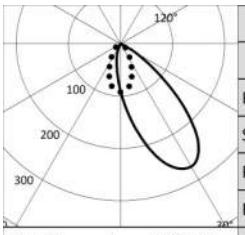
WIDE FLOOD ASYMMETRIC LOUVER



2700K		H(m)	D1(m)	D2(m)	Emax(lx)
Ra80			42°	49°	
Fixture Power	7W	1	1.01	1.05	185
Source Flux	926lm	2	2.01	2.11	46
Fixture Flux	175lm	3	3.02	3.16	21
Efficacy	26lm/W	4	4.03	4.22	12
TS1432 Imax=270cd/klm	Imax 250cd	5	5.03	5.27	7



3000K		H(m)	D1(m)	D2(m)	Emax(lx)
Ra80			42°	49°	
Fixture Power	7W	1	1.01	1.05	193
Source Flux	967lm	2	2.01	2.11	48
Fixture Flux	182lm	3	3.02	3.16	21
Efficacy	27lm/W	4	4.03	4.22	12
TS1432 Imax=270cd/klm	Imax 261cd	5	5.03	5.27	8



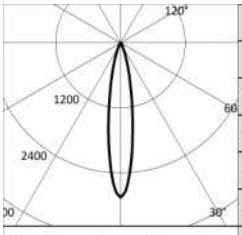
4000K		H(m)	D1(m)	D2(m)	Emax(lx)
Ra80			42°	49°	
Fixture Power	7W	1	1.01	1.05	200
Source Flux	1001lm	2	2.01	2.11	50
Fixture Flux	189lm	3	3.02	3.16	22
Efficacy	28lm/W	4	4.03	4.22	12
TS1432 Imax=270cd/klm	Imax 271cd	5	5.03	5.27	8

JUPITER DOWNLIGHT

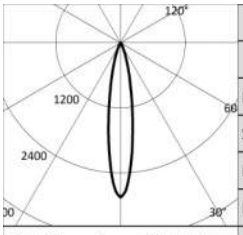
PHOTOMETRY

IES FILES WATTAGE AND EFFICIENCY CALCULATIONS BASED WITH SUPPLIED DRIVER

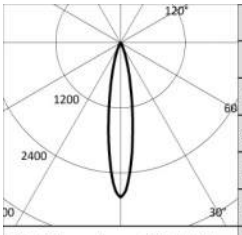
SPOT HONEYCOMB LOUVER



2700K		H(m)	D(m)	Emax(lx)
Ra80			18°	
Fixture Power	7W	1	0.32	2633
Source Flux	926lm	2	0.63	658
Fixture Flux	409lm	3	0.95	293
Efficacy	60lm/W	4	1.27	165
TS1427 Imax=2844cd/klm	Imax	2633cd	5	1.59	105

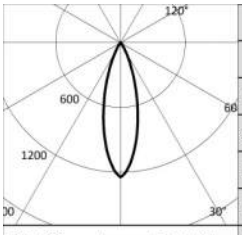


3000K		H(m)	D(m)	Emax(lx)
Ra80			18°	
Fixture Power	7W	1	0.32	2750
Source Flux	967lm	2	0.63	687
Fixture Flux	427lm	3	0.95	306
Efficacy	63lm/W	4	1.27	172
TS1427 Imax=2844cd/klm	Imax	2750cd	5	1.59	110

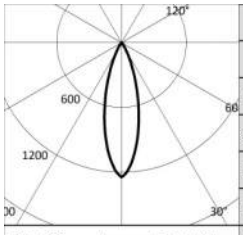


4000K		H(m)	D(m)	Emax(lx)
Ra80			18°	
Fixture Power	7W	1	0.32	2847
Source Flux	1001lm	2	0.63	712
Fixture Flux	442lm	3	0.95	316
Efficacy	65lm/W	4	1.27	178
TS1427 Imax=2844cd/klm	Imax	2847cd	5	1.59	114

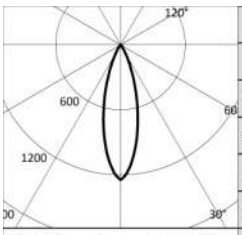
FLOOD HONEYCOMB LOUVER



2700K		H(m)	D(m)	Emax(lx)
Ra80			29°	
Fixture Power	7W	1	0.52	1149
Source Flux	926lm	2	1.05	287
Fixture Flux	366lm	3	1.57	128
Efficacy	54lm/W	4	2.09	72
TS1428 Imax=1241cd/klm	Imax	1149cd	5	2.61	46

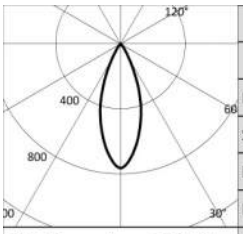


3000K		H(m)	D(m)	Emax(lx)
Ra80			29°	
Fixture Power	7W	1	0.52	1200
Source Flux	967lm	2	1.05	300
Fixture Flux	383lm	3	1.57	133
Efficacy	56lm/W	4	2.09	75
TS1428 Imax=1241cd/klm	Imax	1200cd	5	2.61	48

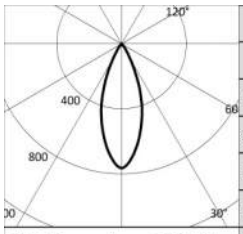


4000K		H(m)	D(m)	Emax(lx)
Ra80			29°	
Fixture Power	7W	1	0.52	1243
Source Flux	1001lm	2	1.05	311
Fixture Flux	396lm	3	1.57	138
Efficacy	58lm/W	4	2.09	78
TS1428 Imax=1241cd/klm	Imax	1243cd	5	2.61	50

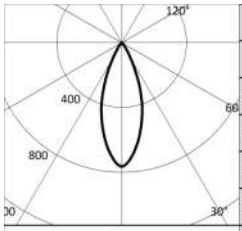
WIDE FLOOD HONEYCOMB LOUVER



2700K		H(m)	D(m)	Emax(lx)
Ra80			38°	
Fixture Power	7W	1	0.68	707
Source Flux	926lm	2	1.37	177
Fixture Flux	317lm	3	2.05	79
Efficacy	47lm/W	4	2.73	44
TS1429 Imax=763cd/klm	Imax	707cd	5	3.41	28



3000K		H(m)	D(m)	Emax(lx)
Ra80			38°	
Fixture Power	7W	1	0.68	738
Source Flux	967lm	2	1.37	185
Fixture Flux	331lm	3	2.05	82
Efficacy	49lm/W	4	2.73	46
TS1429 Imax=763cd/klm	Imax	738cd	5	3.41	30



4000K		H(m)	D(m)	Emax(lx)
Ra80			38°	
Fixture Power	7W	1	0.68	764
Source Flux	1001lm	2	1.37	191
Fixture Flux	343lm	3	2.05	85
Efficacy	50lm/W	4	2.73	48
TS1429 Imax=763cd/klm	Imax	764cd	5	3.41	31

Features

Kurba Small is a direct view, small profile, energy efficient and flexible LED strip suitable for outdoor wet locations capable of horizontal/side bends and vertical/top bends with a 2″ bending radius. The silicone material offers excellent heat, weather, UV, and solvent resistance and has a special coating to repel dust and dirt accumulation.

Applications
Indoor/Outdoor dry & wet location

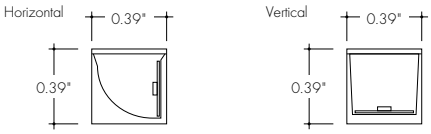
Materials
Silicone for red list approved, as well as heat, weather, UV, and solvent resistance

Dimming
Dot Free even illumination. Also available with Black Lens

Average Life (L70)
50,00 Hours

Approvals
24VDC Class 2 wet listed, IP67

Warranty
3 years



Finish Options (see page 2 for additional information)

Base ☐ White

Premium ■ Black

Technical Information

Bending Direction	Horizontal		Vertical		
Output	**44SO**	**44HO**	**44SO**	**44HO**	**60SO** (Black Lens Only)
Light Output at 3000K	85 lm/ft	163 lm/ft	96 lm/ft	180 lm/ft	16 lm/ft
Average Power Consumption at 4'	1.37 W/ft	2.74 W/ft	1.37 W/ft	2.74 W/ft	1.37 W/ft
Efficacy	62 lm/W	59 lm/W	70 lm/W	66 lm/W	12 lm/W
Ordering Increment	3.28″		3.28″		1.4″
Maximum Run Length (In Series)	49′	24′	49′	24′	33′
Operating Temperature	-40°F to 149°F	-40°F to 131°F	-40°F to 149°F	-40°F to 131°F	-40°F to 149°F

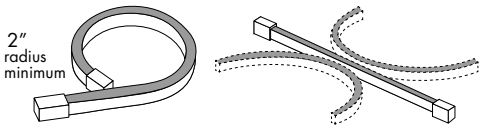
CCT INFO / LUMEN MULTIPLIER

Color Temperature	Multiplier (ref. -3000K)
2200K	0.93
2400K	1.00
2700K	1.00
3000K	1.06
3500K	1.06
4000K	1.00

Note: 80 CRI

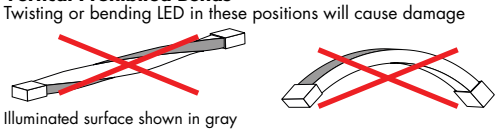
Constraints

Horizontal Bend Direction
Bend LED in these positions only to avoid damage



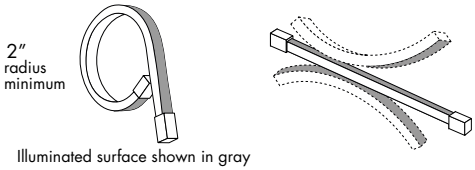
Illuminated surface shown in gray

Vertical Prohibited Bends
Twisting or bending LED in these positions will cause damage



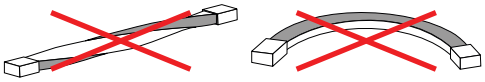
Illuminated surface shown in gray
Do not make sharp bends near the endcap

Vertical Bend Direction
Bend LED in these positions only to avoid damage



Illuminated surface shown in gray

Horizontal Prohibited Bends
Twisting or bending LED in these positions will cause damage



Illuminated surface shown in gray
Do not make sharp bends near the endcap

Ordering Code

MODEL	RATING	BEND DIRECTION	LENGTH	OUTPUT[1]	CCT	LENS[2]	MOUNTING	FINISH	FEED POSITION LEFT	FEED POSITION RIGHT
KBS - Kurba Small	W - Wet	HB - Horizontal Bending VB - Vertical Bending	SEE PCC CHART ON PAGES 6 AND 8	44SO - Standard 44HO - High	22K - 2200K 24K - 2400K 27K - 2700K 30K - 3000K 35K - 3500K 40K - 4000K	SF - Silicone Frosted	NA - See Page 4 for orderable mounting accessories	WH - White	INJECTION MOLD IME - End Feed 1 IMB - Back Feed 1 IMSA - Side 1 Feed IMSB - Side 2 Feed[3] NPF - No Power Feed[4]	INJECTION MOLD IME - End Feed 1 IMB - Back Feed 1 IMSA - Side 1 Feed IMSB - Side 2 Feed[3] NPF - No Power Feed[4]
				60SO - Standard	26K - 2600K 42K - 4200K	BL - Black Lens[2]	NA - See Page 4 for orderable mounting accessories	BK - Black		

Feeds come with 118″ wire leads

1 - Title 24 JA8 compliance achievable, contact factory for specific requests
2 - **BL** Lens only available with **VB** - Vertical Bend Direction
3 - **IMSB** - Side 2 Feed not available with **HB** - Horizontal Bending
4 - **NPF-NPF** for Feed Position 1&2 is not a valid configuration option

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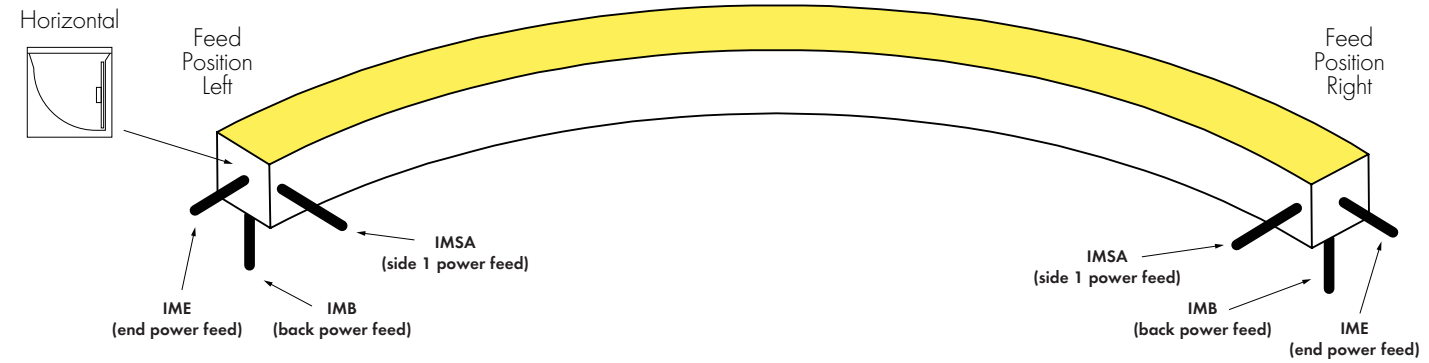
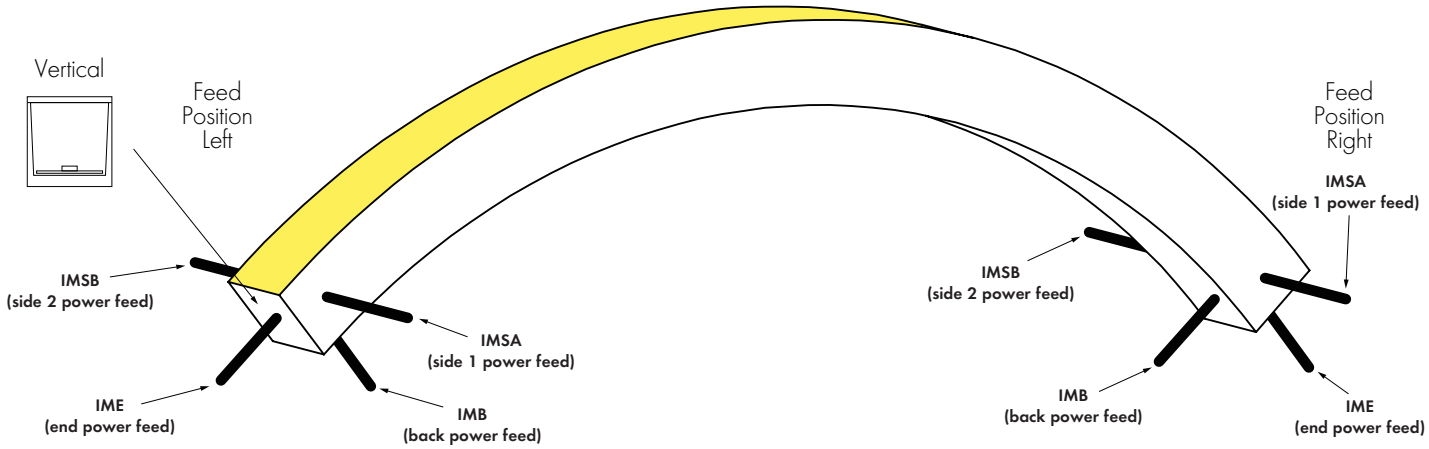
www.luminii.com T: 224-333-6033

Powerfeeds and Connectors

Power Feed Position Options and Orientation

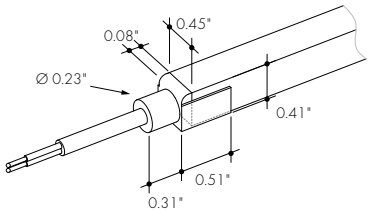




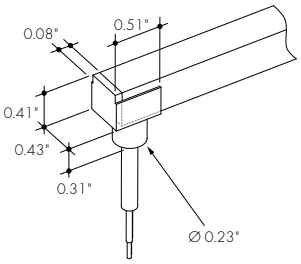
NOTE: IMSB - Side 2 Feed not available with HB - Horizontal Bending

Linking and Extension Cable Options

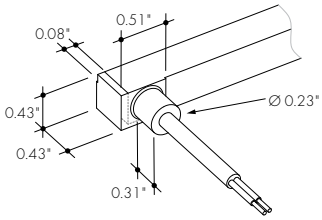
END CONNECTOR
Injection-molded End Connector
-IME



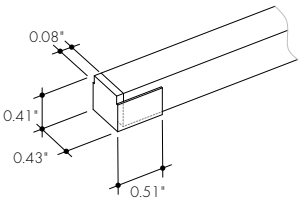
BACK CONNECTOR
Injection-molded Back Connector
-IMB



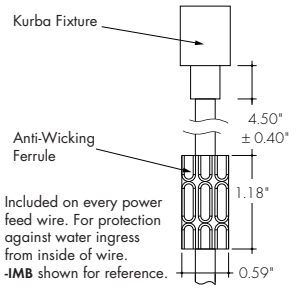
SIDE CONNECTOR
Injection-molded Side Connector
-IMSA and **-IMSB**



ENDCAP (NO CONNECTOR)
Injection-molded Cap (No Connector)
-NPF



ANTI-WICKING FERRULE
Included on every power feed wire



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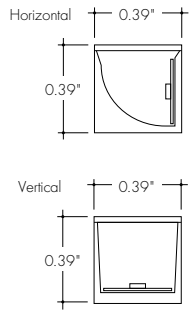
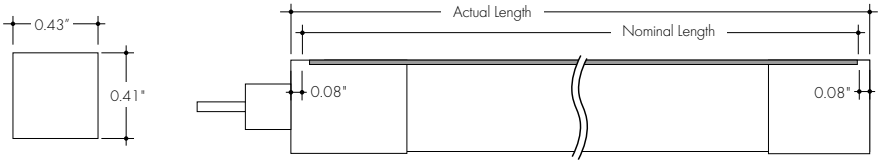
Product Dimensions

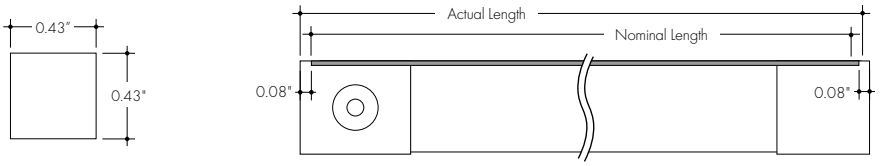
Kurba Small Cross Sections



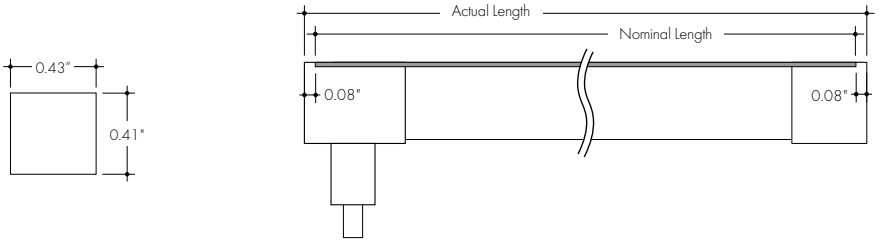
Example Feed Position
IME - NPF
End Feed 1 to
No Power Feed



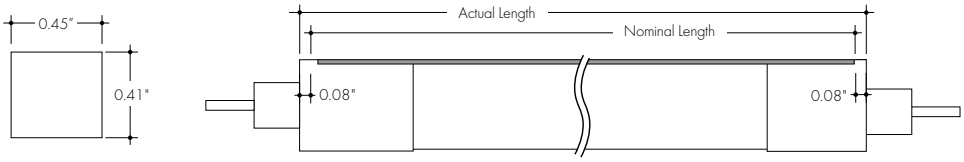
Example Feed Position
IMSA - NPF
Side A Feed to
No Power Feed



Example Feed Position
IMB - NPF
Back Feed 1 to
No Power Feed



Example Feed Position
IME - IME
End Feed 1 and
End Feed 1

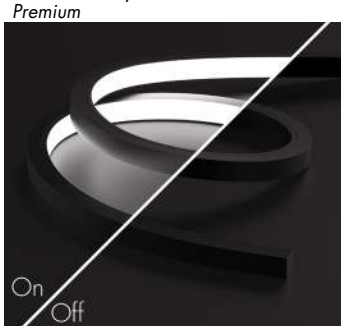


Finish Options

- Kurba's base finish is a crisp white which brings a timeless, clean aesthetic that brightens and enhances any space.
- Also available with a blackout aesthetic - the Black Lens paired with the Black Finish provides for a sleek, all black profile that keeps the strip concealed in the off-state.

White
Base

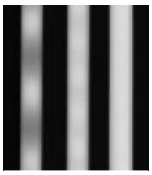
Black Finish w/ Black Lens
Premium



*LUMINII RESERVES THE RIGHTS TO CHANGE SPECIFICATION & INSTRUCTION WITHOUT NOTICE

Light Transmission and Dotting

Output Options	Lens/Accessory: Silicone Frosted/ White Finish	Lens/Accessory: Black Lens/ Black Finish
44SO	ND	N/A
44HO	ND	N/A
60SO	N/A	ND
Transmission Percentage	100%	100%

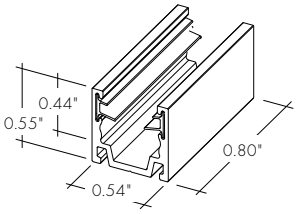


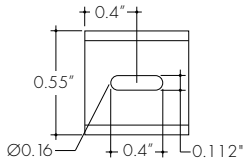
CD **SD** **ND**

CD - Clear Dotting
SD - Slight Dotting
ND - No Dotting

Mounting Accessories & Optional Connectors

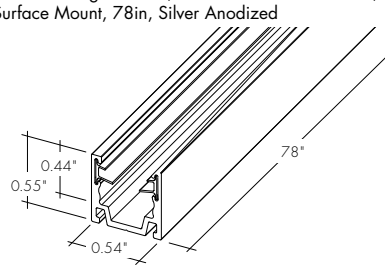
MC-KBS-SAP-SM-0.8-SA
KBS Mounting Channel, Serrated Aluminum Profile, Surface Mount, 0.8in, Silver Anodized

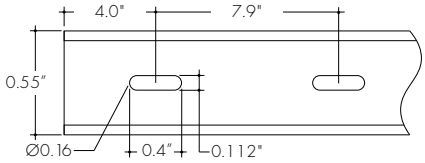




Aluminum mounting bracket providing grip. For use with light strip mounted to the ceiling. 1 recommended every 8 in.

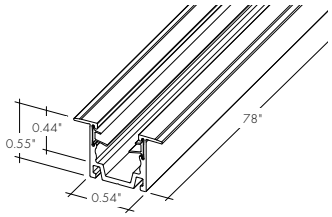
MC-KBS-SAP-SM-78-SA
KBS Mounting Channel, Serrated Aluminum Profile, Surface Mount, 78in, Silver Anodized

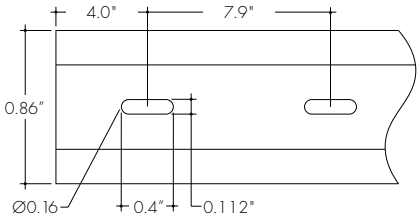




Aluminum mounting channel providing grip. For use with light strip mounted to the ceiling.

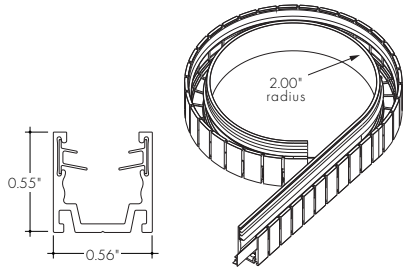
MC-KBS-FSAP-TR-78-SA
KBS Mounting Channel, Flanged Serrated Aluminum Profile, Trimmed Recessed Mount, 78in, Silver Anodized

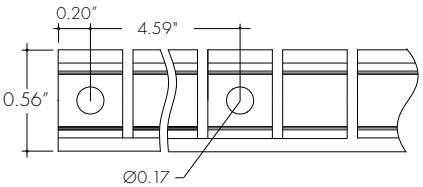




Flanged aluminum mounting channel providing grip. For use with light strip mounted to the ceiling.

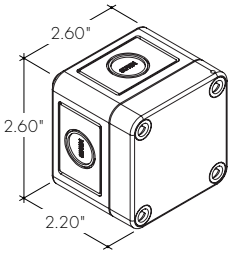
MC-KBS-BSAP-HB-SM-38-SA
KBS Mounting Channel, Bendable Serrated Aluminum Profile, Horizontal Bending, Surface Mount, 38in, Silver Anodized



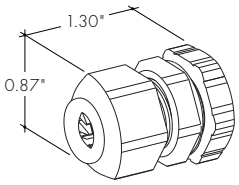


For use with light strip mounted to the ceiling.
NOTE: For use with **HB** - Horizontal Bend only. Mounting Channel Bending Radius is 7.87" in opposite direction

LVSP-WET
Splice box: wet rated, low voltage, gray



LVSP-WET-CM
Connector for splice box, low voltage for cable management, gray



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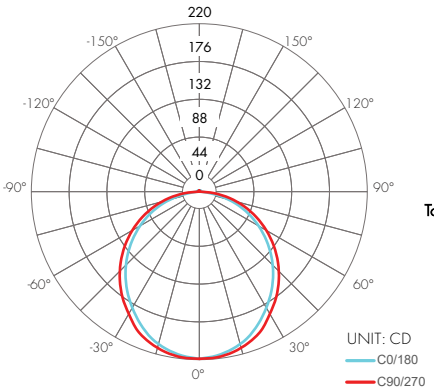
Photometry

KBS-W-HB-48-44HO-30K-R80-SF-NA-WH

Kurba Small, Horizontal Bend, 4ft, 3000K, 80 CRI, 44HO, Silicone Frosted Lens



Zonal Lumen Summary 3000K

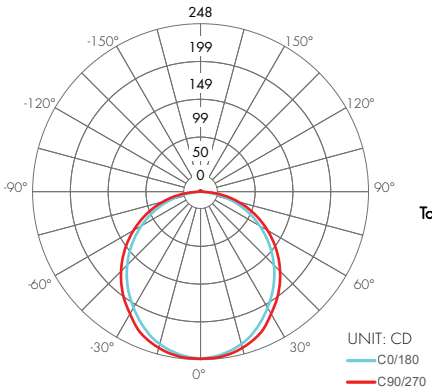
Zone	Lumen	% Fixture
0-30	170	26.0%
0-40	233	35.7%
0-60	491	75.2%
0-90	639	98.0%
Total 0-180	652	100.0%

Beam Angle

112°

KBS-W-VB-48-44HO-30K-R80-SF-NA-WH

Kurba Small, Vertical Bend, 4ft, 3000K, 80 CRI, 44HO, Silicone Frosted Lens



Zonal Lumen Summary 3000K

Zone	Lumen	% Fixture
0-30	191	26.5%
0-40	262	36.4%
0-60	552	76.6%
0-90	709	98.5%
Total 0-180	720	100.0%

Beam Angle

112°

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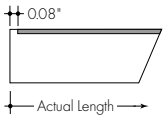
44SO | Power Consumption Per Fixture Length

Based on operation with PDCU series of power supplies. Use Acutal Length for Order Code Entry
Tolerance for Actual Lengths less than 6 ft is +/- 0.2", Actual Lengths between 6 ft and 16 ft is +/- 0.3", and Actual Lengths greater than 16 ft is +/- 0.6"

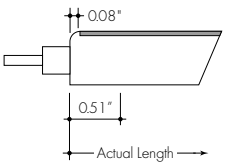
Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)
7	0.8	6.7	125	14.3	124.8	243	27.8	242.9	(30 ft) 361	41.3	361.0	(40 ft) 479	54.8	479.1
10	1.1	10.0	128	14.6	128.1	246	28.1	246.2	365	41.7	364.3	483	55.2	482.4
(1 ft) 14	1.5	13.3	(11 ft) 132	15.0	131.4	250	28.5	249.5	368	42.0	367.6	486	55.5	485.7
17	1.9	16.6	135	15.4	134.7	(21 ft) 253	28.9	252.8	(31 ft) 371	42.4	370.9	489	55.9	489.0
20	2.3	19.8	138	15.8	137.9	256	29.3	256.1	374	42.8	374.2	(41 ft) 493	56.3	492.3
(2 ft) 23	2.6	23.1	141	16.1	141.2	260	29.6	259.3	378	43.2	377.4	496	56.7	495.5
27	3.0	26.4	(12 ft) 145	16.5	144.5	(22 ft) 263	30.0	262.6	381	43.5	380.7	499	57.0	498.8
30	3.4	29.7	148	16.9	147.8	266	30.4	265.9	(32 ft) 384	43.9	384.0	502	57.4	502.1
33	3.8	33.0	151	17.3	151.1	269	30.8	269.2	388	44.3	387.3	(42 ft) 506	57.8	505.4
(3 ft) 36	4.1	36.2	(13 ft) 155	17.6	154.4	273	31.2	272.5	391	44.7	390.6	509	58.2	508.7
40	4.5	39.5	158	18.0	157.6	(23 ft) 276	31.5	275.7	394	45.0	393.8	512	58.5	512.0
43	4.9	42.8	161	18.4	160.9	279	31.9	279.0	(33 ft) 397	45.4	397.1	(43 ft) 515	58.9	515.2
46	5.3	46.1	164	18.8	164.2	282	32.3	282.3	401	45.8	400.4	519	59.3	518.5
(4 ft) 50	5.6	49.4	(14 ft) 168	19.1	167.5	286	32.7	285.6	404	46.2	403.7	522	59.7	521.8
53	6.0	52.7	171	19.5	170.8	(24 ft) 289	33.0	288.9	(34 ft) 407	46.5	407.0	525	60.0	525.1
56	6.4	55.9	174	19.9	174.0	292	33.4	292.1	410	46.9	410.2	(44 ft) 529	60.4	528.4
(5 ft) 59	6.8	59.2	178	20.3	177.3	296	33.8	295.4	414	47.3	413.5	532	60.8	531.6
63	7.1	62.5	(15 ft) 181	20.6	180.6	(25 ft) 299	34.2	298.7	417	47.7	416.8	535	61.2	534.9
66	7.5	65.8	184	21.0	183.9	302	34.5	302.0	(35 ft) 420	48.0	420.1	(45 ft) 538	61.5	538.2
69	7.9	69.1	187	21.4	187.2	305	34.9	305.3	424	48.4	423.4	542	61.9	541.5
(6 ft) 73	8.3	72.3	(16 ft) 191	21.8	190.4	309	35.3	308.5	427	48.8	426.7	545	62.3	544.8
76	8.6	75.6	194	22.1	193.7	(26 ft) 312	35.7	311.8	430	49.2	429.9	548	62.7	548.0
79	9.0	78.9	197	22.5	197.0	315	36.0	315.1	(36 ft) 433	49.5	433.2	(46 ft) 552	63.0	551.3
(7 ft) 82	9.4	82.2	200	22.9	200.3	319	36.4	318.4	437	49.9	436.5	555	63.4	554.6
86	9.8	85.5	(17 ft) 204	23.3	203.6	322	36.8	321.7	440	50.3	439.8	558	63.8	557.9
89	10.1	88.7	207	23.6	206.8	(27 ft) 325	37.2	325.0	(37 ft) 443	50.7	443.1	561	64.2	561.2
92	10.5	92.0	210	24.0	210.1	328	37.5	328.2	447	51.0	446.3	(47 ft) 565	64.5	564.4
(8 ft) 96	10.9	95.3	214	24.4	213.4	332	37.9	331.5	450	51.4	449.6	568	64.9	567.7
99	11.3	98.6	(18 ft) 217	24.8	216.7	(28 ft) 335	38.3	334.8	453	51.8	452.9	571	65.3	571.0
102	11.6	101.9	220	25.1	220.0	338	38.7	338.1	(38 ft) 456	52.2	456.2	(48 ft) 575	65.7	574.3
105	12.0	105.1	223	25.5	223.2	342	39.0	341.4	460	52.5	459.5	578	66.0	577.6
(9 ft) 109	12.4	108.4	(19 ft) 227	25.9	226.5	345	39.4	344.6	463	52.9	462.7	581	66.4	580.8
112	12.8	111.7	230	26.3	229.8	(29 ft) 348	39.8	347.9	466	53.3	466.0	584	66.8	584.1
115	13.1	115.0	233	26.6	233.1	351	40.2	351.2	(39 ft) 470	53.7	469.3	(49ft) 588	67.2	587.4
(10 ft) 118	13.5	118.3	237	27.0	236.4	355	40.5	354.5	473	54.0	472.6			
122	13.9	121.5	(20 ft) 240	27.4	239.7	358	40.9	357.8	476	54.4	475.9			

Note: all values are rounded to the nearest 0.1 inch

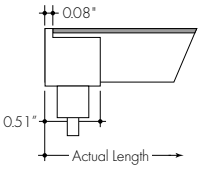
Endcap (No Connector) -NPF



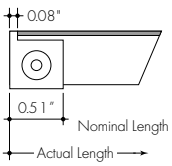
End Connector -IME



Back Connector -IMB



Side Connector -IMSA and -IMSB



*LUMINII RESERVES THE RIGHTS TO CHANGE SPECIFICATION & INSTRUCTION WITHOUT NOTICE

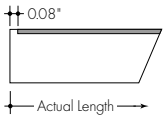
44HO | Power Consumption Per Fixture Length

Based on operation with PDCU series of power supplies. Use Acutal Length for Order Code Entry
Tolerance for Actual Lengths less than 6 ft is +/- 0.2", Actual Lengths between 6 ft and 16 ft is +/- 0.3", and Actual Lengths greater than 16 ft is +/- 0.6"

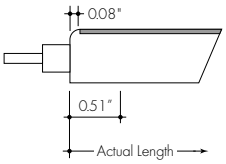
Nominal Length (in)	W	**Actual Length (in)**	Nominal Length (in)	W	**Actual Length (in)**	Nominal Length (in)	W	**Actual Length (in)**
7	**1.5**	6.7	**125**	**28.5**	124.8	**243**	**55.5**	242.9
10	**2.3**	10.0	**128**	**29.3**	128.1	**246**	**56.3**	246.2
(1 ft) 14	**3.0**	13.3	**(11 ft) 132**	**30.0**	131.4	**250**	**57.0**	249.5
17	**3.8**	16.6	**135**	**30.8**	134.7	**(21 ft) 253**	**57.8**	252.8
20	**4.5**	19.8	**138**	**31.5**	137.9	**256**	**58.5**	256.1
(2 ft) 23	**5.3**	23.1	**141**	**32.3**	141.2	**260**	**59.3**	259.3
27	**6.0**	26.4	**(12 ft) 145**	**33.0**	144.5	**(22 ft) 263**	**60.0**	262.6
30	**6.8**	29.7	**148**	**33.8**	147.8	**266**	**60.8**	265.9
33	**7.5**	33.0	**151**	**34.5**	151.1	**269**	**61.5**	269.2
(3 ft) 36	**8.3**	36.2	**(13 ft) 155**	**35.3**	154.4	**273**	**62.3**	272.5
40	**9.0**	39.5	**158**	**36.0**	157.6	**(23 ft) 276**	**63.1**	275.7
43	**9.8**	42.8	**161**	**36.8**	160.9	**279**	**63.8**	279.0
46	**10.5**	46.1	**164**	**37.5**	164.2	**282**	**64.6**	282.3
(4 ft) 50	**11.3**	49.4	**(14 ft) 168**	**38.3**	167.5	**286**	**65.3**	285.6
53	**12.0**	52.7	**171**	**39.0**	170.8	**(24 ft) 289**	**66.1**	288.9
56	**12.8**	55.9	**174**	**39.8**	174.0	**292**	**66.8**	292.1
(5 ft) 59	**13.5**	59.2	**178**	**40.5**	177.3	**296**	**67.6**	295.4
63	**14.3**	62.5	**(15 ft) 181**	**41.3**	180.6			
66	**15.0**	65.8	**184**	**42.0**	183.9			
69	**15.8**	69.1	**187**	**42.8**	187.2			
(6 ft) 73	**16.5**	72.3	**(16 ft) 191**	**43.5**	190.4			
76	**17.3**	75.6	**194**	**44.3**	193.7			
79	**18.0**	78.9	**197**	**45.0**	197.0			
(7 ft) 82	**18.8**	82.2	**200**	**45.8**	200.3			
86	**19.5**	85.5	**(17 ft) 204**	**46.5**	203.6			
89	**20.3**	88.7	**207**	**47.3**	206.8			
92	**21.0**	92.0	**210**	**48.0**	210.1			
(8 ft) 96	**21.8**	95.3	**214**	**48.8**	213.4			
99	**22.5**	98.6	**(18 ft) 217**	**49.5**	216.7			
102	**23.3**	101.9	**220**	**50.3**	220.0			
105	**24.0**	105.1	**223**	**51.0**	223.2			
(9 ft) 109	**24.8**	108.4	**(19 ft) 227**	**51.8**	226.5			
112	**25.5**	111.7	**230**	**52.5**	229.8			
115	**26.3**	115.0	**233**	**53.3**	233.1			
(10 ft) 118	**27.0**	118.3	**237**	**54.0**	236.4			
122	**27.8**	121.5	**(20 ft) 240**	**54.8**	239.7			

Note: all values are rounded to the nearest 0.1 inch

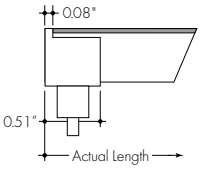
Endcap (No Connector) -NPF



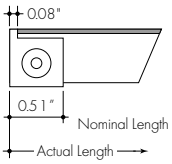
End Connector -IME



Back Connector -IMB



Side Connector -IMSA and -IMSB



*LUMINII RESERVES THE RIGHTS TO CHANGE SPECIFICATION & INSTRUCTION WITHOUT NOTICE

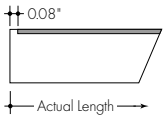
60SO | Power Consumption Per Fixture Length

Based on operation with PDCU series of power supplies. Use Acutal Length for Order Code Entry
Tolerance for Actual Lengths less than 6 ft is +/- 0.2", Actual Lengths between 6 ft and 16 ft is +/- 0.3", and Actual Lengths greater than 16 ft is +/- 0.6"

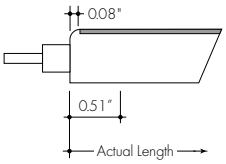
Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)	Nominal Length (in)	W	Actual Length (in)
7	0.8	7.2	58	6.6	57.8	(8ft) 109	12.4	108.4	159	18.2	159.0	210	24.0	209.6
8	1.0	8.6	59	6.8	59.2	110	12.6	109.8	161	18.3	160.4	211	24.1	211.0
10	1.1	10.0	(5ft) 60	6.9	60.6	111	12.7	111.2	162	18.5	161.8	212	24.3	212.4
11	1.3	11.4	62	7.1	62.0	113	12.9	112.6	163	18.7	163.2	214	24.4	213.8
(1ft) 13	1.5	12.8	63	7.2	63.4	114	13.0	114.0	165	18.8	164.6	215	24.6	215.2
14	1.6	14.2	65	7.4	64.8	116	13.2	115.4	166	19.0	166.0	(18ft) 217	24.8	216.6
16	1.8	15.6	66	7.6	66.2	117	13.4	116.8	(14ft) 168	19.1	167.4	218	24.9	218.0
17	1.9	17.0	68	7.7	67.6	118	13.5	118.2	169	19.3	168.8	220	25.1	219.4
19	2.1	18.4	69	7.9	69.0	(10ft) 120	13.7	119.6	170	19.5	170.2	221	25.2	220.8
20	2.3	19.8	71	8.1	70.4	121	13.8	121.0	172	19.6	171.6	222	25.4	222.2
21	2.4	21.2	(6ft) 72	8.2	71.8	123	14.0	122.4	173	19.8	173.0	224	25.6	223.6
23	2.6	22.6	73	8.4	73.2	124	14.2	123.8	175	19.9	174.4	225	25.7	225.0
(2ft) 24	2.8	24.1	75	8.5	74.7	125	14.3	125.3	176	20.1	175.8	227	25.9	226.4
25	2.9	25.5	76	8.7	76.1	127	14.5	126.7	177	20.3	177.3	(19ft) 228	26.1	227.9
26	3.1	26.9	78	8.9	77.5	128	14.6	128.1	179	20.4	178.7	229	26.2	229.3
28	3.2	28.3	79	9.0	78.9	130	14.8	129.5	(15ft) 180	20.6	180.1	231	26.4	230.7
30	3.4	29.7	80	9.2	80.3	131	15.0	130.9	182	20.7	181.5	232	26.5	232.1
31	3.6	31.1	82	9.3	81.7	(11ft) 132	15.1	132.3	183	20.9	182.9	234	26.7	233.5
32	3.7	32.5	83	9.5	83.1	134	15.3	133.7	184	21.1	184.3	235	26.9	234.9
34	3.9	33.9	(7ft) 85	9.7	84.5	135	15.4	135.1	186	21.2	185.7	236	27.0	236.3
35	4.0	35.3	86	9.8	85.9	137	15.6	136.5	187	21.4	187.1	238	27.2	237.7
(3ft) 37	4.2	36.7	87	10.0	87.3	138	15.8	137.9	189	21.6	188.5	239	27.3	239.1
38	4.4	38.1	89	10.1	88.7	139	15.9	139.3	190	21.7	189.9	(20ft) 241	27.5	240.5
39	4.5	39.5	90	10.3	90.1	141	16.1	140.7	191	21.9	191.3	242	27.7	241.9
41	4.7	40.9	92	10.5	91.5	142	16.2	142.1	(16ft) 193	22.0	192.7	243	27.8	243.3
42	4.8	42.3	93	10.6	92.9	(12ft) 144	16.4	143.5	194	22.2	194.1	245	28.0	244.7
44	5.0	43.7	94	10.8	94.3	145	16.6	144.9	196	22.4	195.5	246	28.1	246.1
45	5.2	45.1	(8ft) 96	10.9	95.7	146	16.7	146.3	197	22.5	196.9	248	28.3	247.5
46	5.3	46.5	97	11.1	97.1	148	16.9	147.7	198	22.7	198.3	249	28.5	248.9
(4ft) 48	5.5	47.9	99	11.3	98.5	149	17.1	149.1	200	22.8	199.7	251	28.6	250.3
49	5.6	49.4	100	11.4	100.0	151	17.2	150.5	201	23.0	201.1	(21ft) 252	28.8	251.7
51	5.8	50.8	102	11.6	101.4	152	17.4	152.0	203	23.2	202.6	253	28.9	253.2
52	6.0	52.2	103	11.7	102.8	153	17.5	153.4	(17ft) 204	23.3	204.0	255	29.1	254.6
53	6.1	53.6	104	11.9	104.2	155	17.7	154.8	205	23.5	205.4	256	29.3	256.0
55	6.3	55.0	106	12.1	105.6	(13ft) 156	17.9	156.2	207	23.6	206.8			
56	6.4	56.4	107	12.2	107.0	158	18.0	157.6	208	23.8	208.2			

Note: all values are rounded to the nearest 0.1 inch

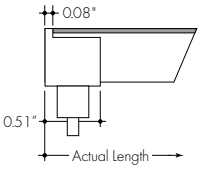
Endcap (No Connector) -NPF



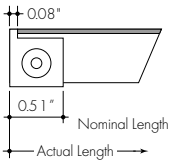
End Connector -IME



Back Connector -IMB



Side Connector -IMSA and -IMSB



*LUMINII RESERVES THE RIGHTS TO CHANGE SPECIFICATION & INSTRUCTION WITHOUT NOTICE

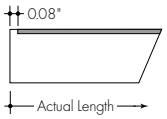
60SO | Power Consumption Per Fixture Length cont.

Based on operation with PDCU series of power supplies. Use Acutal Length for Order Code Entry
Tolerance for Actual Lengths less than 6 ft is +/- 0.2", Actual Lengths between 6 ft and 16 ft is +/- 0.3", and Actual Lengths greater than 16 ft is +/- 0.6"

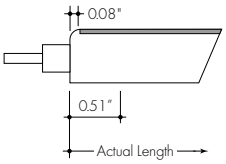
Nominal Length (in)	W	**Actual Length (in)**	Nominal Length (in)	W	**Actual Length (in)**	Nominal Length (in)	W	**Actual Length (in)**
258	**29.4**	257.4	**308**	**35.2**	307.9	**359**	**41.0**	358.5
259	**29.6**	258.8	**310**	**35.4**	309.3	**(30ft) 360**	**41.2**	359.9
260	**29.7**	260.2	**311**	**35.5**	310.7	**361**	**41.3**	361.3
262	**29.9**	261.6	**(26ft) 312**	**35.7**	312.1	**363**	**41.5**	362.7
263	**30.1**	263.0	**314**	**35.9**	313.5	**364**	**41.6**	364.1
(22ft) 265	**30.2**	264.4	**315**	**36.0**	314.9	**366**	**41.8**	365.5
266	**30.4**	265.8	**317**	**36.2**	316.3	**367**	**42.0**	366.9
267	**30.5**	267.2	**318**	**36.3**	317.7	**368**	**42.1**	368.3
269	**30.7**	268.6	**319**	**36.5**	319.1	**370**	**42.3**	369.7
270	**30.9**	270.0	**321**	**36.7**	320.5	**371**	**42.4**	371.1
272	**31.0**	271.4	**322**	**36.8**	321.9	**(31ft) 373**	**42.6**	372.5
273	**31.2**	272.8	**(27ft) 324**	**37.0**	323.3	**374**	**42.8**	373.9
274	**31.4**	274.2	**325**	**37.1**	324.8	**376**	**42.9**	375.4
(23ft) 276	**31.5**	275.6	**326**	**37.3**	326.2	**377**	**43.1**	376.8
277	**31.7**	277.0	**328**	**37.5**	327.6	**378**	**43.2**	378.2
279	**31.8**	278.5	**329**	**37.6**	329.0	**380**	**43.4**	379.6
280	**32.0**	279.9	**331**	**37.8**	330.4	**381**	**43.6**	381.0
281	**32.2**	281.3	**332**	**37.9**	331.8	**383**	**43.7**	382.4
283	**32.3**	282.7	**333**	**38.1**	333.2	**(32ft) 384**	**43.9**	383.8
284	**32.5**	284.1	**335**	**38.3**	334.6	**385**	**44.0**	385.2
286	**32.6**	285.5	**(28ft) 336**	**38.4**	336.0	**387**	**44.2**	386.6
287	**32.8**	286.9	**338**	**38.6**	337.4	**388**	**44.4**	388.0
(24ft) 288	**33.0**	288.3	**339**	**38.7**	338.8	**390**	**44.5**	389.4
290	**33.1**	289.7	**340**	**38.9**	340.2	**391**	**44.7**	390.8
291	**33.3**	291.1	**342**	**39.1**	341.6	**392**	**44.9**	392.2
293	**33.4**	292.5	**343**	**39.2**	343.0	**(33ft) 394**	**45.0**	393.6
294	**33.6**	293.9	**344**	**39.4**	344.4			
296	**33.8**	295.3	**346**	**39.5**	345.8			
297	**33.9**	296.6	**(29ft) 348**	**39.7**	347.2			
298	**34.1**	298.0	**349**	**39.9**	348.6			
(25ft) 300	**34.2**	299.5	**350**	**40.0**	350.1			
301	**34.4**	300.9	**352**	**40.2**	351.5			
302	**34.6**	302.3	**353**	**40.4**	352.9			
304	**34.7**	303.7	**355**	**40.5**	354.3			
305	**34.9**	305.1	**356**	**40.7**	355.7			
307	**35.0**	306.5	**357**	**40.8**	357.1			

Note: all values are rounded to the nearest 0.1 inch

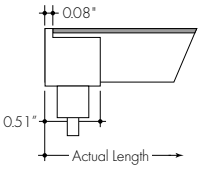
Endcap (No Connector) -NPF



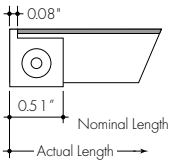
End Connector -IME



Back Connector -IMB



Side Connector -IMSA and -IMSB



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Power Supplies

See Power Supply instructions and spec sheet for wiring information. For a complete list of compatible dimmers, see Compatible Dimming Chart on the Resources page.

For use with Static White

Ordering Code Universal Dimming Power Supplies 1% 120VAC - 277VAC

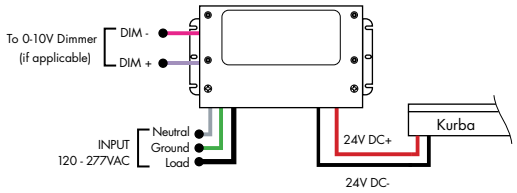
MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT
PS-Power Supply, 120-277VAC	UNI-0-10V Dimming, Phase Dimming	W-Wet	30-30 Watts 60-60 Watts 96-96 Watts 3x96-3x96 Watts	24-24 VDC

Compatibility: View a complete list of compatible dimmers on product page (Link)

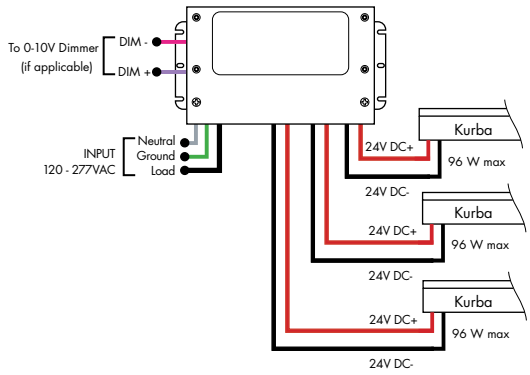
0-10V - 1% dimming
MLV/ELV/TRIAC - 1% dimming, consult dimming compatibility chart

MODELS	PS-UNI-W-30W	PS-UNI-W-60W	PS-UNI-W-96W	PS-UNI-W-3X96W
Length	6.50″	7.40″	8.66"	11.85"
Width	3.73″	3.73″	3.73"	4.32"
Depth	1.61″	1.61″	1.61"	1.81"

PS-UNI-W-96



PS-UNI-W-3X96



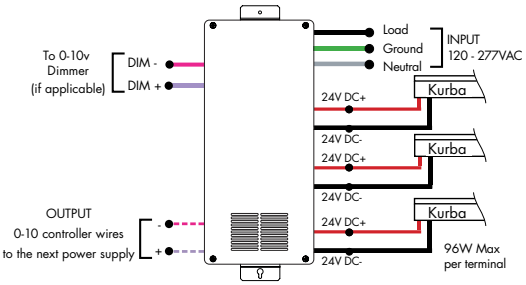
For use with Static White

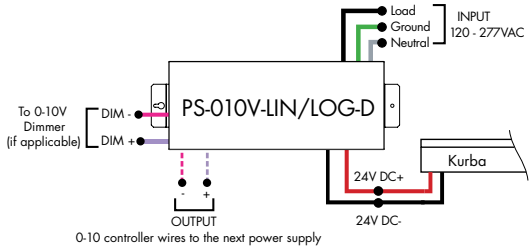
0-10V Dimming Power Supplies 0.1% 120VAC - 277VAC

MODEL	POWER	OUTPUT	INPUT CONTROL	ENVIRONMENT
PS-Power Supply, 120-277VAC	96-96 Watts 3x96-3x96 Watts	24-24 VDC	010V-LIN-0-10V Dimming (0.1%), Linear 010V-LOG-0-10V Dimming (0.1%), Logarithmic	D-Dry

MODELS	96W	3X96
Length	14.40"	15.00"
Width	5.20"	6.62"
Depth	2.60"	4.45"

PS-010V-LIN/LOG-D-3X96





*LUMINII RESERVES THE RIGHTS TO CHANGE SPECIFICATION & INSTRUCTION WITHOUT NOTICE

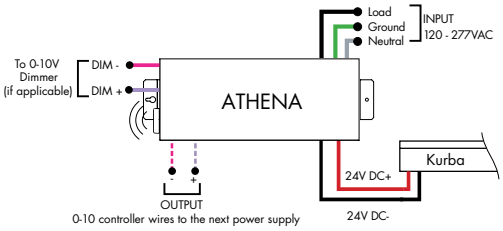
Power Supplies

See Power Supply instructions and spec sheet for wiring information. For a complete list of compatible dimmers, see Compatible Dimming Chart on the Resources page.

For use with Static White

Athena 0-10V LED Driver

MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT	FEATURE
PS-Power Supply, 120-277VAC	010V-LIN-0-10V Dimming (0.1%), Linear 010V-LOG-0-10V Dimming (0.1%), Logarithmic	D-Dry	96-96 Watts	24-24 VDC	AWNR-Athena



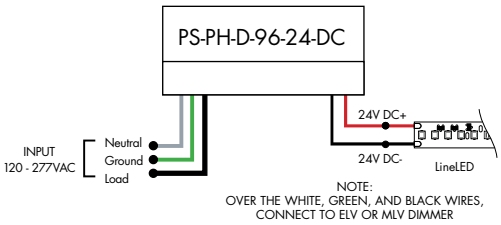
MODELS	96W
Length	14.40"
Width	5.20"
Depth	2.60"

For use with Static White

Ordering Code Phase Dimming Power Supply 1% 120VAC - 277VAC

MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT	OUTPUT CONTROL
PS-Power Supply, 120-277VAC	PH-Phase Dimming (Triac, ELV, MLV)	D-Dry	96-96 Watts	24-24 VDC	DC-Direct Current

MLV/ELV/TRIAC - 1% dimming, consult dimming compatibility chart (Link)



MODELS	96W
Length	8.25"
Width	4.10"
Depth	1.56"

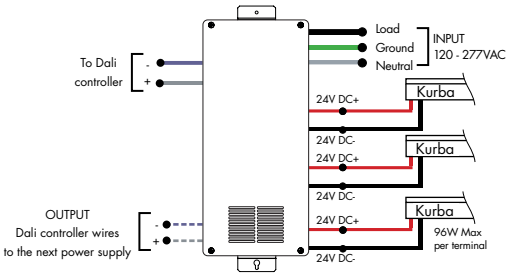
For use with Static White

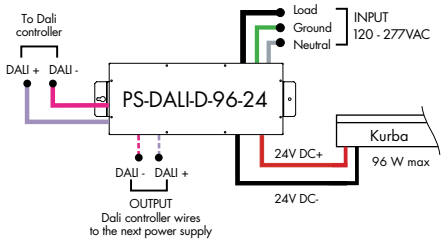
DALI Dimming Power Supplies 0.1% 120VAC - 277VAC

MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT
PS-Power Supply, 120-277VAC	DALI-DALI (0.1%)	D-Dry	96-96 Watts 3x96-3x96 Watts	24-24 VDC

Model	96W	3X96
Length	14.40"	15.00"
Width	5.20"	6.62"
Depth	2.60"	4.56"

PS-DALI-D-3X96-24





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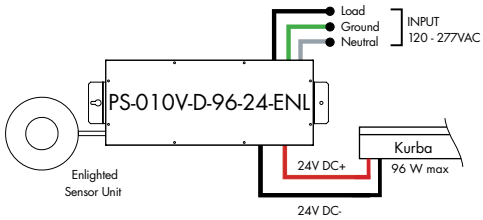
Power Supplies

See Power Supply instructions and spec sheet for wiring information. For a complete list of compatible dimmers, see Compatible Dimming Chart on the Resources page.

For use with Static White

Athena 0-10V LED Driver

MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT	FEATURE
PS-Power Supply, 120-277VAC	010V-0-10V Dimming (1%)	D-Dry	96-96 Watts	24-24 VDC	ENL-0-10V Enlightened



Model	96W
Length	14.40"
Width	5.20"
Depth	2.60"

For use with Static White

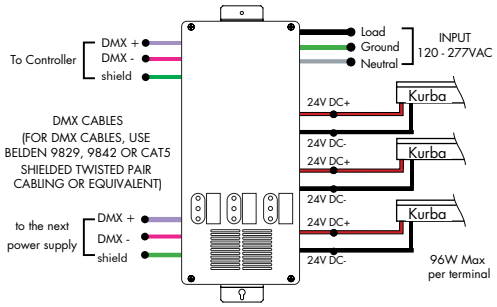
Requires Zonal Control

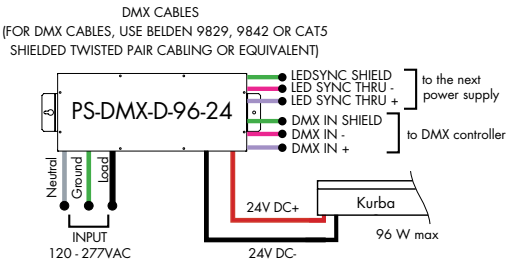
DMX Dimming Power Supplies 0.1% 120VAC - 277VAC

MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT
PS-Power Supply, 120-277VAC	DMX-DMX (0.1%)	D-Dry	96-96 Watts 3x96-3x96 Watts	24-24 VDC

MODELS	96W	3X96
Length	14.40"	15.00"
Width	5.20"	6.62"
Depth	2.60"	4.56"

PS-DMX-D-3X96-24

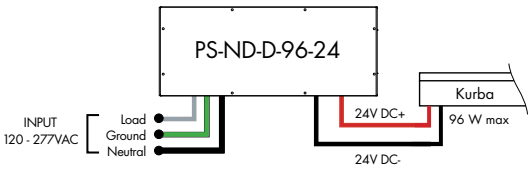




For use with Static White

DMX Dimming Power Supplies 0.1% 120VAC - 277VAC

MODEL	INPUT CONTROL	ENVIRONMENT	WATTAGE	OUTPUT
PS-Power Supply, 120-277VAC	ND-Non Dimming	D-Dry	96-96 Watts	24-24 VDC



MODELS	96W
Length	14.40"
Width	5.20"
Depth	2.60"

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Power Supplies

See Power Supply instructions and spec sheet for wiring information. For a complete list of compatible dimmers, see Compatible Dimming Chart on the Resources page.

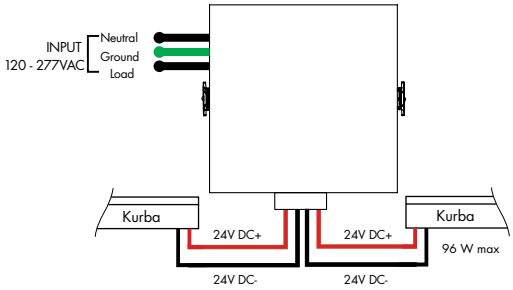
For use with Static White

In-Ground Power Supplies

MODEL		INPUT CONTROL		ENVIRONMENT		WATTAGE		OUTPUT
	-		-		-		-	
PS120-Power Supply, 120VAC PS240-Power Supply, 240VAC PS277-Power Supply, 277VAC		ELV-ELV Dimming (1%)		IG-In Ground		2X96-2X96 Watts		24-24 VDC

MODELS	2X96W
Length	8.40"
Width	8.30"
Depth	8.10"

PS120-ELV-IG-2X96-24



LUTRON®

Luminii is a Lutron OEM Advantage Partner

Lutron Power Supplies 1%

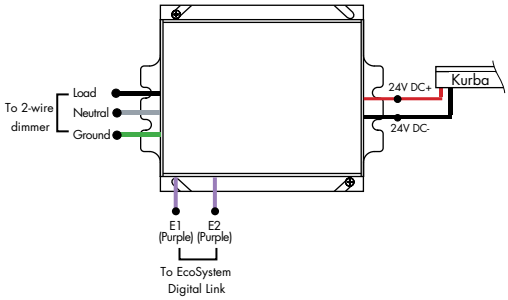
MODEL

L3DA4U1UKL-CV240

HiLume™ 1% EcoSystem Voltage LED driver
40W max

MODELS	L3DA4U1UKL-CV240
Length	4.98"
Width	4.00"
Depth	2.62"

L3DA4U1UKL-CV240



LUTRON®

Luminii is a Lutron OEM Advantage Partner

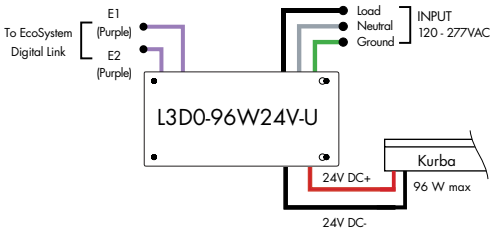
Lutron Power Supplies 0.1%

MODEL

L3D0-96W24V-U

HiLume™ 0.1% EcoSystem Voltage LED Driver with Soft-On, Fade-to-Black™
96W max

MODELS	L3D0
Length	10.50"
Width	5.50"
Depth	2.00"



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LUMINIS®

EG152
ELLINGTON
POLE MOUNT

PROJECT NAME: **QUANTITY:** **TYPE:**

ORDERING CODE:

DarkSky Approved
Commercial Luminaire
Refer to pg 3

① Innovative cast aluminum arm that blends seamlessly with the luminaire. Capable of withstanding strong wind loads. Clamps to a Ø4" (102mm) pole.

② Sleek and timeless silhouette with no visible hardware. Features a die-cast aluminum housing with an internally sealed driver.

③ Recessed optical lens that delivers three distinct comfort light distributions: symmetric, asymmetric and pathway.

④ High-performance and efficient LED engine featuring glare-reducing technology, delivering a uniformly illuminated surface enhancing visual comfort

EG152-PM

EG152-APA

EG152-APS

MATERIALS

Ellington's main housing is made of corrosion resistant A360 aluminum alloy, ensures optimal heat dissipation and a copper content of less than 0.1%. The optical lens is made of acrylic.

ELECTRICAL DRIVER

Driver is 0-10V dimming-ready (dims to 1%) with: 120-277 multi-volt (50-60Hz) or 347-480 high-volt (50-60Hz), operating temperature range of -40ºC/-40ºF to 45ºC/113ºF, output over voltage protection, output over current protection and output short circuit protection with auto-recovery.

LED LIGHT ENGINE

Offered in 2700K/3000K/3500K/4000K CCT with 80 CRI. 70% LED lumen maintenance at 60,000 hours (L70/B50) based on IESNA LM-80-08 LED extrapolated life, calculated per IESNA TM-21-21.

FINISH

Five-stage preparation process including preheating of cast aluminum parts for air extraction, and an environmentally friendly alloy sealant. Polyester powder coating is applied through an electrostatic process and oven cured for long term finish.

CERTIFICATION

UL Certified to Canadian and U.S. safety standards. Certified for use in wet locations. Rated IP66/IK07. Photometric testing performed by an independent laboratory in accordance with IES LM-79-08 standards at 25°C. Actual performance may differ as a result of end-user environment and application.

DESIGN

Ellington mostly consists of aluminum (housing) and PMMA (optical lens), both of which are recyclable materials. In addition, its design minimizes the amount of assembling hardware needed. It can also be quickly disassembled to facilitate recycling.

WARRANTY

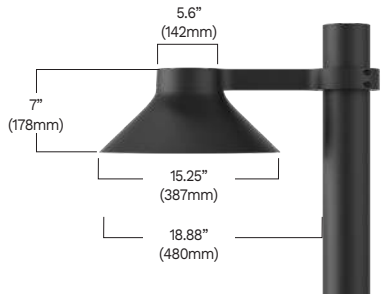
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: https://www.acuitybrands.com/support/warranty/terms-and-conditions

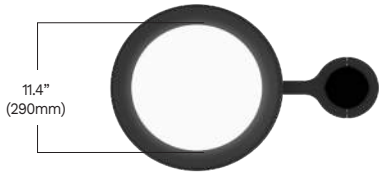
MOUNTING

Clamps around Ø4" (102mm) pole with a set of 4 x 1/4"-20 x 1" lg. socket head screws. See option details.

MEASUREMENTS

Maximum weight: 14.83 lbs (6.72 kg)
EPA: 0.56 ft^2





LUMINIS.COM
Toll free: (866) 586-4647 | Fax: (514) 683-8872 | Email: info@luminis.com
260 Labrosse, Pointe-Claire (QC) Canada H9R 5L5

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ORDERING CODE

*SERIES	*LIGHT OUTPUT	*DISTRIBUTION	*CCT	*VOLTAGE	*MOUNTING
EG152	**L2L20** 2250 lm / 25w **L2L30** 3180 lm / 37w **L2L40** 4087 lm / 50w **L2L50** 5042 lm / 64w[1] **L2L60** 6661 lm / 90w[2] **Delivered lumens calculated at 4000K/80CRI. Symmetric distribution. Refer to reference table for outputs at other distribution types. Typical power consumption. Refer to LCF table for outputs at other CCTs.**	**SYM** Symmetric **ASY** Asymmetric **PATH** Pathway	**27K** 2700K **30K** 3000K **35K** 3500K **40K** 4000K	**MVOLT** 120V-277V **HVOLT** 347V-480V	**PM** Pole mount **APA** Pole mount shepherd arm attachment **APS** Post top shepherd arm attachment **PM2** Twin mount with 180° offset[3]

CONTROLS	MOTION SENSOR	SURGE PROTECTOR	*FINISH	ENVIRONMENT
NLTH nLight AIR 2.0 integrated in head[4]	**MS** Motion sensor inside luminaire[5]	**SP** Surge protector	**BKT** Jet black **BZT** Bronze **CHT** Champagne **DGT** Gun metal **GRT** Titanium gray **MST** Matte silver **SGT** Steel gray **WHT** Snow white **CMC** Custom matched color[6] **RAL** RAL color[7]	**MG** Marine grade paint[8] **NT** Natatorium suitable[9]

Looking for Fuse, Photocell?
Refer to Luminis PRS4 pole spec sheet.

NOTES
*- Denotes a required field
1- Available only with SYM and PATH.
2- Available only with SYM.
3- If PM2 is selected, fixture quantity ordered must be in increments of 2.
4- Not available with MS, HVOLT and photocell (option found on PRS4 pole). Must link to external nLight Air network. Dims to 10%.
5- Not available with NLTH, HVOLT and photocell (option found on PRS4 pole).
6- Contact factory to coordinate custom matching color.
7- Specify RAL number.
8- Marine grade paint for harsh, coastal environment and exposure to salt water. Additional delay required.
9- Available only in WHT and BKT finish.

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DarkSky Approved
Commercial Luminaire

DARKSKY APPROVED ORDERING CODE

*SERIES	*LIGHT OUTPUT	*DISTRIBUTION	*CCT	*VOLTAGE	*MOUNTING
EG152	**L2L20** 2250 lm / 25w **L2L30** 3180 lm / 37w **L2L40** 4087 lm / 50w **L2L50** 5042 lm / 64w **L2L60** 6661 lm / 90w **Delivered lumens calculated at 4000K/80CRI. Symmetric distribution. Refer to reference table for outputs at other distribution types. Typical power consumption. Refer to LCF table for outputs at other CCTs.**	**SYM** Symmetric	**27K** 2700K **30K** 3000K	**MVOLT** 120V-277V **HVOLT** 347V-480V	**PM** Pole mount **APA** Pole mount shepherd arm attachment **APS** Post top shepherd arm attachment **PM2** Twin mount with 180° offset[1]

CONTROLS	MOTION SENSOR	SURGE PROTECTOR	*FINISH	ENVIRONMENT
NLTH nLight AIR 2.0 integrated in head[2]	**MS** Motion sensor inside luminaire[3]	**SP** Surge protector	**BKT** Jet black **BZT** Bronze **CHT** Champagne **DGT** Gun metal **GRT** Titanium gray **MST** Matte silver **SGT** Steel gray **WHT** Snow white **CMC** Custom matched color[4] **RAL** RAL color[5]	**MG** Marine grade paint[6] **NT** Natatorium suitable[7]

Looking for Fuse, Photocell?
Refer to Luminis PRS4 pole spec sheet.

NOTES
*- Denotes a required field
1- If PM2 is selected, fixture quantity ordered must be in increments of 2.
2- Not available with MS, HVOLT and photocell (option found on PRS4 pole). Must link to external nLight Air network. Dims to 10%.
3- Not available with NLTH, HVOLT and photocell (option found on PRS4 pole).
4- Contact factory to coordinate custom matching color.
5- Specify RAL number.
6- Marine grade paint for harsh, coastal environment and exposure to salt water. Additional delay required.
7- Available only in WHT and BKT finish.

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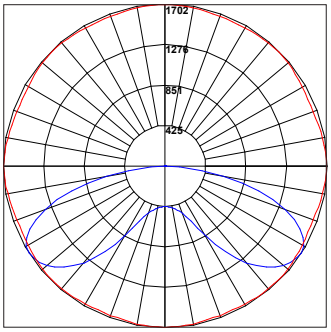
TYPICAL PHOTOMETRY SUMMARY

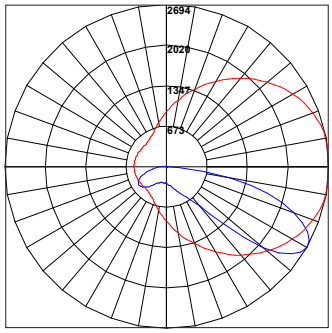
EG152-L2L60-SYM



Total Lms: 6661 Lumens
Total Input Watts: 90 W
Efficacy: 74 Lumens/Watt
BUG: B3-U0-G2
CCT/CRI: 4000K/80
Maximum Candela: 1702@ 180°H/57.5°V

SYM - LUMEN CONVERSION FACTOR (LCF)		
CCT	CRI	LCF
2700K	80	0.91
3000K	80	0.94
3500K	80	0.98
4000K	80	1.00

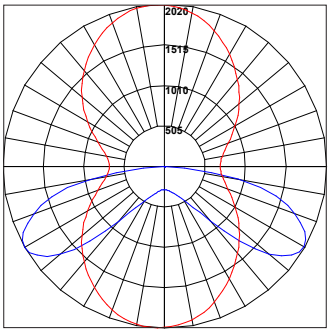
EG152-L2L40-ASY



Total Lms: 4645 Lumens
Total Input Watts: 92 W
Efficacy: 51 Lumens/Watt
BUG: B1-U0-G2
CCT/CRI: 4000K/80
Maximum Candela: 2694@ 7.5°H/60°V

ASY/PATH - LUMEN CONVERSION FACTOR (LCF)		
CCT	CRI	LCF
2700K	80	0.94
3000K	80	0.94
3500K	80	1.00
4000K	80	1.00

EG152-L2L50-PATH



Total Lms: 5001 Lumens
Total Input Watts: 92 W
Efficacy: 54 Lumens/Watt
BUG: B3-U0-G3
CCT/CRI: 4000K/80
Maximum Candela: 2020@ 92.5°H/60°V

All Photometry shown use the 80CRI 4000K LEDs.
Please visit our web site www.luminis.com for complete I.E.S. file.

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REFERENCE TABLE - LIGHT OUTPUT

SYM - SYMMETRIC

	TOTAL LMS/WATTS	EFFICACY	BUG
L2L20	2250 lm / 25.4 w	89 lm/w	B1-U0-G1
L2L30	3180 lm / 37.4 w	85 lm/w	B2-U0-G1
L2L40	4087 lm / 49.9 w	82 lm/w	B2-U0-G1
L2L50	5042 lm / 64 w	79 lm/w	B2-U0-G1
L2L60	6661 lm / 90 w	74 lm/w	B3-U0-G2

ASY - ASYMMETRIC

	TOTAL LMS/WATTS	EFFICACY	BUG
L2L20	2051 lm / 37 w	55 lm/w	B1-U0-G1
L2L30	3350 lm / 63 w	53 lm/w	B1-U0-G1
L2L40	4645 lm / 92 w	51 lm/w	B1-U0-G2

PATH - PATHWAY

	TOTAL LMS/WATTS	EFFICACY	BUG
L2L20	2107 lm / 35.1 w	60 lm/w	B1-U0-G1
L2L30	3056 lm / 52.7 w	58 lm/w	B2-U0-G2
L2L40	4070 lm / 72.6 w	56 lm/w	B2-U0-G2
L2L50	5001 lm / 92 w	54 lm/w	B3-U0-G3

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OPTION DETAILS

NLTH
nLight AIR Control gen2 and black antenna integrated in head.

APS
Ø 1 5/8" shepherd aluminum post top mount, with a cast aluminum tenon to fit with Ø 4" pole with wall 0.125" (3.75" ID). EPA: 0.15

APA
Ø 1 5/8" shepherd aluminum side pole mount.. EPA: 0.15

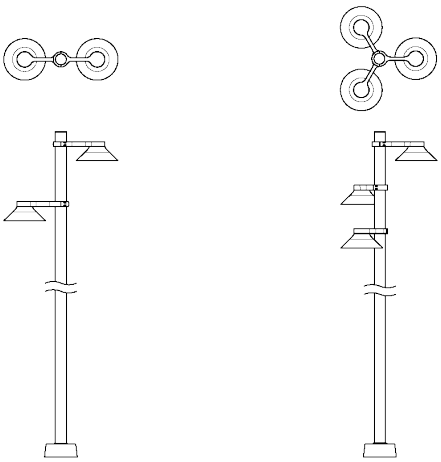
PM2
Twin mount 180º offset. Installation on 4" poles. For twin mount applications, the luminaires are mounted directly to each other.

Note: If PM2 is selected, fixture quantity ordered must be in increments of 2.

PM
Pole mount.
Installation on 4" poles.

CUSTOM CONFIGURATIONS

*For reference only. Available only on 4" poles. RFA "modified product" request must be submitted for custom configurations.



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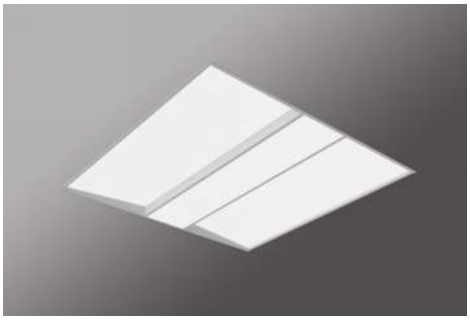
PINNACLE ARCHITECTURAL LIGHTING®

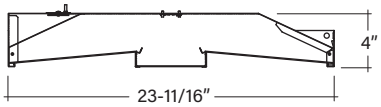
Project Name _____

Date _____ Type _____



TRAVERSE TR22

2x2 Architectural Recessed



Key Features

- Three-piece luminous lens design offers elevated style and visual comfort
- White or Silver center rails
- Up to 6000 delivered lumens (2x2) with 80CRI or 90CRI options
- High performance efficacy up to 147 lumens per watt
- Lift and shift lenses allow for easy room-side maintenance
- Multiple integrated control options for enhanced energy savings
- 5-year limited warranty

Example Part #: TR22-W-830HO-G1-U-FSD-1-0-W

TR22 - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [ ]

SHIELDING | *CRI, CCT & OUTPUT* | *MOUNTING* | *VOLTAGE* | *DRIVER* | *CIRCUITING* | *BATTERY & EMERGENCY* | *FINISH* | *FIXTURE OPTIONS* | *CONTROLS*

__	_____	_____	_
SHIELDING	**SOURCE[1] QS**	**MOUNTING**	**VOLTAGE**
W - Satine Lens with White Rails QS **S** - Satine Lens with Silver Rails *Shielding pg. 2*	**_27__** - 2700K **_30__** - 3000K **_35__** - 3500K **_40__** - 4000K **CL_____** - Custom Lumens **CW_____** - Custom Watts *Lumen Output pg. 2*	**G1 -** 15/16" Grid QS **G9 -** 9/16" Grid QS **GS -** Screw Slot Grid QS **FL -** Flanged *Mounting pg. 3*	**U -** Universal *(120 thru 277V)* QS **1 -** 120V QS **2 -** 277V QS **3 -** 347V *Voltage pg. 3*

___	_	___	__
DRIVER	**CIRCUITING**	**BATTERY & EMERGENCY**	**FINISH**
FSD - Factory Select Driver *(1%, 0-10v)* QS **PL2 -** Advance Xitanium *(1%, 0-10v)* **OL2 -** eldoLED Optotronic *(1%, 0-10v)* **OL2 -** eldoLED Optotronic 347v *(1%, 0-10v)* **OL5 -** eldoLED Optotronic *(1%, 0-10v)* **EE1 -** eldoLED ECOdrive *(1%, 0-10v)* **EE2 -** eldoLED ECOdrive *(1%, 0-10v)* **LH1 -** Lutron Hi-lume *(1%, EcoSystem)* **PR1 -** Advance Xitanium SR *Driver pg. 4*	**1 -** Single Circuit QS **E -** Emergency QS *(entire fixture)* **N -** Night Light QS *(entire fixture)* *Circuiting pg. 4*	**0 -** None QS **FSB** - Factory Select Battery QS **FSG -** Factory Select ALCR **GI -** Iota ETS DR **GB -** Bodine GTD **1ILL -** Iota 10W, Lithium, Self Testing **1PLL -** Bodine 10W, Lithium, Self Testing *Battery and Emergency pg. 4*	**W -** White QS *Finish pg. 5*

____	___
FIXTURE OPTIONS[2]	**CONTROLS[3]**
QS - QuickShip QS **TW -** Through-wiring **CP -** Chicago Plenum QS **AR -** Air Return **AM -** Antimicrobial Paint **FW6 -** 6' Flex Whip QS *Fixture Options pg. 5*	**DLMFC -** Wattstopper DLM *(wired)* **DLMFS -** Wattstopper LLLC *(wireless)* **SNSLM -** Encelium SensiLUM *(wireless)* **LEVIS0 -** Leviton Intellect Sensor *(wireless)* **ENL_-** Enlighted IOT *(wireless)* **ENL2_ -** Enlighted 2-Wire IOT *(wireless)* *Controls pg. 6*

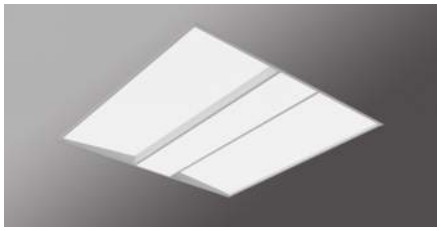
[1]When specifying SOURCE the first _ is for specifying either 8 - 80CRI or 9 - 90CRI. The ending _ _ are for specifying output, example HO - High Output. See output charts for more information. [2]If specifying QS, QS must be used in fixture options section of part number to qualify. [3]Controls can only be used with Single Circuit (1) or Emergency Circuit (E). See Controls chart on page 5 for driver options and more information.

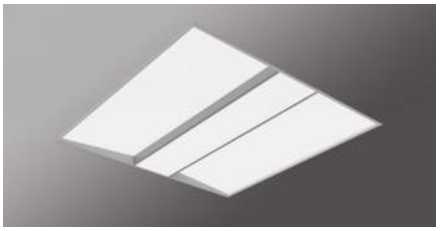
Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

Shielding

- Three piece acrylic diffuse lens
- Fully luminous housing with optimal glare control
- Highly reflective white reflectors maintain uniform lens brightness

W	S
Satine Lens with White Rails	Satine Lens with Silver Rails





Output

- Specify either 80 or 90 CRI
- Longer lead-time may apply for 90 CRI. Consult factory.
- 90 CRI = R9≥50

Custom Output- Lumens OR Wattage

CL_____	Specify CRI, CCT and desired lumens (i.e. CL8351200)	*Specify lumens between standard offering listed below. Lumens are specified per color temp*
CW_____	Specify CRI, CCT and desired wattage (i.e. CW94015)	*Specify watts between standard offering listed below*

80 CRI

	Color	Output	Watts	Shielding			
				W White Trim		**S** Silver Trim	
				Lumens	*LPW*	*Lumens*	*LPW*
830LO	3000K	Low	17.0	2416	142	2295	135
830MO	3000K	Middle	28.5	3820	134	3629	127
830HO	3000K	High	38.2	4995	131	4746	124
830VHO	3000K	Very High	46.1	5875	127	5581	121
835LO	3500K	Low	17.0	2426	143	2305	136
835MO	3500K	Middle	28.5	3836	135	3645	128
835HO	3500K	High	38.2	5016	131	4766	125
835VHO	3500K	Very High	46.1	5899	128	5605	122
840LO	4000K	Low	17.0	2491	147	2367	139
840MO	4000K	Middle	28.5	3939	138	3742	131
840HO	4000K	High	38.2	5151	135	4893	128
840VHO	4000K	Very High	46.1	6058	131	5755	125

90 CRI

927LO	2700K	Low	17.0	2004	118	1903	112
927MO	2700K	Middle	28.5	3168	111	3010	106
927HO	2700K	High	38.2	4143	108	3935	103
927VHO	2700K	Very High	46.1	4872	106	4628	100
930LO	3000K	Low	17.0	2052	121	1950	115
930MO	3000K	Middle	28.5	3245	114	3083	108
930HO	3000K	High	38.2	4243	111	4031	106
930VHO	3000K	Very High	46.1	4990	108	4741	103
935LO	3500K	Low	17.0	2142	126	2035	120
935MO	3500K	Middle	28.5	3387	119	3217	113
935HO	3500K	High	38.2	4428	116	4207	110
935VHO	3500K	Very High	46.1	5208	113	4947	107
940LO	4000K	Low	17.0	2199	129	2089	123
940MO	4000K	Middle	28.5	3477	122	3303	116
940HO	4000K	High	38.2	4546	119	4319	113
940VHO	4000K	Very High	46.1	5346	116	5079	110

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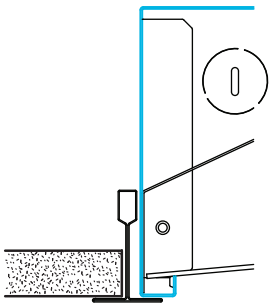
Mounting

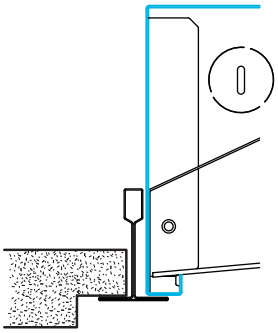
- TRAVERSE can be ordered for all grid types. See below for fixture placement in relation to the tile for each grid type
- Grid retention clips integral to housing and require mechanical attachment
- Tie off fixture to structure with retention wires
- Refer to installation instructions during installation
- Approved for dry/damp location
- Maximum fixture weight is 15.4lbs

G1

1" Grid Mount
Works with 15/16" grid ceiling types. See profile for fixture position in relation to ceiling grid and tile.



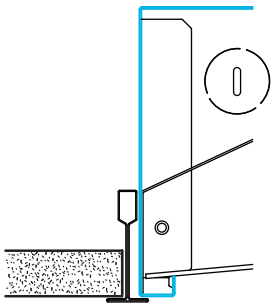
Standard Tile



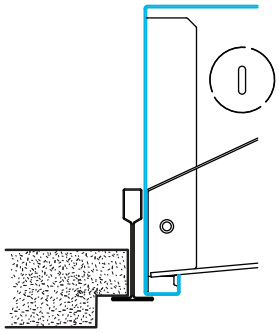
Tegular Tile

G9

9/16" Grid Mount
Works with 9/16" grid ceiling type. For tegular tile installations, fixture position will not be flush to the bottom of the tile. See tegular tile profile image below.



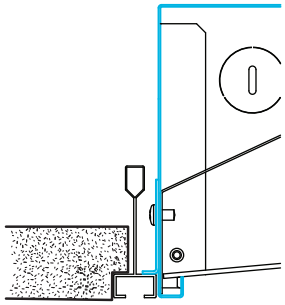
Standard Tile



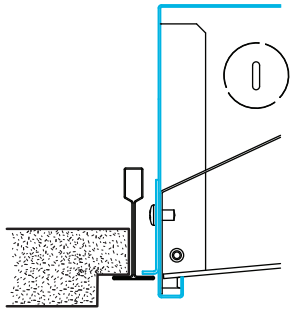
Tegular Tile

GS

Screw Slot Mounting
Works with screw slot and bolt slot grid ceiling types.



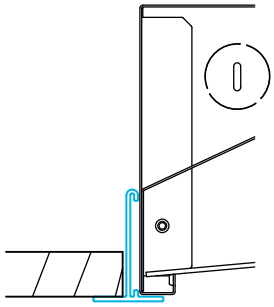
Standard Tile

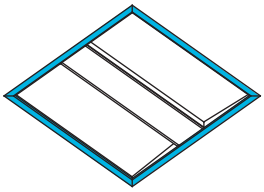


Tegular Tile

FL

Flange Kit
A separate flange kit is supplied for installations into inaccessible or drywall applications. Flange kit ships from factory uninstalled separately from fixture.





Voltage

- Some TRAVERSE configurations will not accommodate all voltage options; consult with factory

U	Universal
1	120 volt
2	277 volt
3	347 volt

Driver

- Standard Driver Option = FSD
- Driver Lifetime: 50,000 hours at 25°C ambient operating conditions
- For more Driver options, see Pinnacle Resource Guide
- Some TRAVERSE configurations will not accommodate all driver options; consult with factory

0-10V Drivers	
FSD	Factory Select Driver 1%, 0-10v
PL2	Advance Xitanium 1%, 0-10v
OL2	eldoLED Optotronic, 1%, 0-10v
OL4	eldoLED Optotronic 347v, 1% 0-10v, requires 347v option
EE1	eldoLED ECOdrive 1%, 0-10v, Logarithmic
EE2	eldoLED ECOdrive 1%, 0-10v, Linear
ES1	eldoLED SOLOdrive 0.1%, 0-10v, Logarithmic
ES2	eldoLED SOLOdrive 0%, 0-10v, Linear
OL5	eldoLED Optotronic 1%, 0-10v, AUX
DALI Drivers	
EE3	eldoLED ECOdrive .1%, DALI, Logarithmic
OD1	eldoLED Optotronic 1%, DEXAL
PR1	Advance Xitanium SR, DALI 2, Self powered link
Lutron Drivers	
LH1	Lutron Hi-lume Soft-on, Fade-to-black 1%, EcoSystem, LDE1

Circuiting

- Select fixture circuiting from options below
- Some TRAVERSE configurations will not accommodate all circuiting options; consult with factory

1	Single Circuit
E	Emergency Circuit only
N	Night Light Circuit only

Battery & Emergency

- Select battery or emergency options if required
- Battery duration is 90 minutes
- Test button is integral to fixture
- For more Battery options, see Pinnacle Resource Guide

0	No Battery
FSB	Factory Select Battery 10w, Integral Lithium
FSG	Factory Select ALCR Emergency Control Device, UNV
GI	Iota ETS-DR, Emergency Control Device, UNV
GB	Bodine GTD, Emergency Control Device, 120v or 277v
1ILL	Iota 10w, Integral Lithium, Self Testing
1PLL	Bodine 10w, Integral Lithium, Self Testing

For Approximate Battery Lumen Output

- Multiply battery wattage X fixture LPW shown on Lumen Table
- 10 (watts) x 92.3 (LPW) = 923 battery lumen output

Battery & Emergency Ordering Examples

- Single circuit, 10w integral battery — Ordering Code: 1-1FSB
- Emergency circuit only, 10w integral battery — Ordering Code: E-1PLL

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Finish

- Powder-coat white painted finish

W	White

Fixture Options

- Additional options to enhance the fixture and finish of the product

QS	Quick Ship
TW	Through-Wiring
CP	Chicago Plenum
AM	Antimicrobial Paint
AR	Air Return
FW6	Flex Whip 6′

Quick Ship

Shielding	Output	Mounting	Voltage	Driver	Circuiting	Battery	Finish	Options
10-Day								
W White Rails	80 CRI, All color temperatures, all lumen packages *See pg 2*	**G1** 1″ Grid **G9** 9/16″ Grid **GS** Screw Slot	**U** Universal **1** 120v **2** 277v	**FSD** Factory Select Driver *(1%, 0-10v)*	**1** Single **E** Emergency **N** Night Light	**0** None **FSB** Factory Select Battery	**W** White	**CP** Chicago Plenum **FW6** Flex Whip 6′ 18-gauge

Consult Factory for projects that are larger than 200 units.

Controls

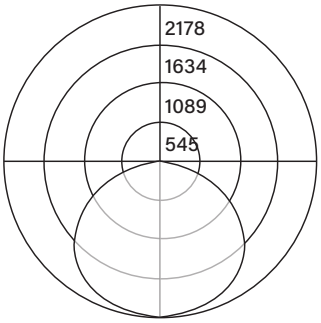
- Pinnacle Lighting offers easy to specify network control solutions that connect to an intelligent centralized system to maximize lighting energy efficiencies or integral sensors for individual fixture control
- Pinnacle Lighting fixtures ship technology ready; commissioning by others
- Controls can only be used with Single Circuit (**1**) or Emergency Circuit (**E**)
- Contact factory for any non-standard configurations for layout, placement, or EM options
- Must specify required driver in Driver section

	Solution	Components	Network/Sensor	Connection	Required Drivers	Limitations
DLMFC	Legrand Wattstopper DLM	LMFC-011	Digital Lighting Management (DLM)	Wired, two RJ45 ports	OL2	Not available with Battery
DLMFS	Legrand Wattstopper LLLC	LMFS-601-W / LMFI-111	Wireless DLM Fixture Sensor	Wireless	OD1, PR1I or 0-10v	0-10v requires interface
SNSLM	Encelium SensiLUM	EN-CLM-PIR-DD-ZB	Encelium, Daylight/PIR Occupancy	Wireless	OD1, OL5	
LEVIS0	Leviton Intellect Sensor	ZL07S-N00	Leviton Intellect, Daylight/PIR Occupancy	Wireless	OL5	
ENLI	Enlighted IOT	SU-5E-IOT	Enlighted, Daylight/PIR Occupancy	Wireless	ANY 0-10V	
ENLC	Enlighted Connected Lighting	SU-5E-CL	Enlighted, Daylight/PIR Occupancy	Wireless	ANY 0-10V	
ENL2I	Enlighted 2-Wire IOT	KIT-SU-5E-D-IOT	Enlighted, Daylight/PIR Occupancy	Wireless	OD1, PR1	
ENL2C	Enlighted 2-Wire Connected Lighting	KIT-SU-5E-D-CL	Enlighted, Daylight/PIR Occupancy	Wireless	OD1, PR1	

Photometrics

Satine Lens

Test #	5157-5
Catalog #	TR22-W-835
Lumens	6209 lm
Watts	46.7 W
Efficacy	133 LPW



Candela Distribution

Vert Angle	Horizontal Angle 0	22.5	45	67.5	90
0	2172	2172	2172	2172	2172
5	2169	2160	2157	2159	2163
10	2134	2124	2125	2131	2136
15	2077	2069	2076	2088	2097
20	1999	1994	2010	2034	2049
25	1902	1902	1932	1969	1990
30	1789	1793	1838	1893	1923
35	1659	1668	1727	1801	1839
40	1515	1529	1600	1686	1731
45	1362	1378	1457	1548	1595
50	1206	1220	1300	1387	1430
55	1040	1052	1126	1201	1239
60	870	880	940	999	1029
65	700	701	746	790	812
70	532	529	557	584	598
75	366	362	377	392	400
80	215	212	215	220	223
85	142	184	175	165	163
90	20	19	20	20	22

Luminance Data (cd/sq.m)

Angle In Degrees	Average 0-Deg	Average 45-Deg	Average 90-Deg
45	5178	5538	6064
55	4875	5278	5809
65	4453	4746	5163
75	3797	3914	4157
85	4394	5394	5021

For all available IES files, please visit our website at pinnacle-ltg.com. Photometry testing in accordance to IESNA-LM-79-08 at an NVLAP accredited testing laboratory. Testing conducted at 25°C ambient conditions

Approvals & Certifications

Construction: Formed 24 gauge cold rolled steel housing. Highly reflective die-formed reflectors maintain uniform lens brightness. Wiring access on both sides and top of housing. Housing designed to maintain optimal temperature of LED diodes and driver and allow for room-side maintenance of lens, driver and LED boards.

Shielding: 3 piece diffuse lens with center spine creating a fully luminous housing with optimal glare control. Available with white or silver lens side rails.

Mounting: Designed to install into acoustical grid and inaccessible ceilings. Specify G1, G9 or GS for acoustical grid ceiling. Specify FL for inaccessible ceilings. Grid retention clips integral to housing and require mechanical attachment. Tie off fixture to structure with retention wires. Maximum fixture weight is 15.4 lbs.

LED: 25°C test environment. Lumen output/wattage has a margin of +/- 5%. Luminaire configurations tested in accordance with IES LM-79. Diodes tested in accordance with IES LM-80. Lifetime calculated using IES TM-21. Minimum lifetime greater than 60,000 hours. Lifetime Projection L70 = 275,000 hours and L90 = 83,000 hours. MacAdam 3-Step Ellipses. For all available IES files, please visit our website at pinnacle-ltg.com.

Color & Lumen Output: Not all lumen packages available. Four lumen packages available. Low (LO), Medium (MO), High (HO) and Very High (VHO). Custom outputs are available. Specify custom lumens or watts between standard offering listed on CRI, CCT & Output page. 80 CRI is available for 3000K, 3500K, and 4000K. 90 CRI is available for 2700K, 3000K, 3500K and 4000K. 90 CRI = R9≥50.

Voltage: Universal (U), 120 volt (1), 277 volt (2) and 347 volt (3) options available. Some TRAVERSE configurations will not accommodate all voltage options; consult with factory.

Driver: Standard Driver Option is Factory Select Driver 0-10V, 1% = FSD. Electronic driver, Power factor is >0.9 with a THD <20%. Driver Lifetime: 50,000 hours at 25°C ambient operating conditions. Ambient operating range: -20°F/-30°C to 87°F/30C. For more driver options, see Pinnacle Resource Guide. Some TRAVERSE configurations will not accommodate all driver options.

Circuiting: Select from single circuit (1), Emergency circuit (E) or Night Light circuit (N). Some TRAVERSE configurations will not accommodate all circuiting options, consult with factory.

Battery & Emergency: Select battery or emergency options if required. If battery or emergency option is not required, enter 0. Battery duration is 90 minutes as standard. Test button is integral to fixture. For more Battery options, see Pinnacle Resource Guide.

Finish: Powder coat white painted finish.

Controls: DLM utilizes wired network connections for digital control through switching and dimming. ENCELIUM SensiLUM sensor provides wireless control, daylight harvesting and PIR occupancy using 0-10V, DEXAL or SR LED drivers. Leviton Intellect sensor provides wireless control, daylight harvesting and PIR occupancy detection using 0-10V, DEXAL or SR LED drivers. Enlighted Smart Sensor provides multi-functionality including daylight harvesting and PIR occupancy; for IOT or Connected platform using 0-10V, DEXAL or SR LED drivers.

Labels: UL and cUL 1598 listed. LO, MO, HO and VHO lumen packages are IC Rated. Approved for dry/damp location unless otherwise noted.

Fixture Weight: 15.4 lbs maximum.

Warranty: TRAVERSE LED offered with a 5-year limited warranty. Covers LED, driver and fixture.

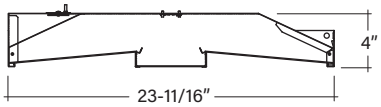
PINNACLE ARCHITECTURAL LIGHTING®

Project Name _____

Date _____ Type _____

TRAVERSE TR24

2x4 Architectural Recessed



Key Features

- Three-piece luminous lens design offers elevated style and visual comfort
- White or Silver center rails
- Up to 8000 delivered lumens (2x4) with 80CRI or 90CRI options
- High performance efficacy up to 154 lumens per watt
- Lift and shift lenses allow for easy room-side maintenance
- Multiple integrated control options for enhanced energy savings
- 5-year limited warranty

Example Part #: TR24-W-830HO-G1-U-FSD-1-0-W

TR24 - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____

SHIELDING	CRI, CCT & OUTPUT	MOUNTING	VOLTAGE	DRIVER	CIRCUITING	BATTERY & EMERGENCY	FINISH	FIXTURE OPTIONS	CONTROLS

SHIELDING (_ _)

W - Satine Lens with White Rails QS
S - Satine Lens with Silver Rails
Shielding pg. 2

SOURCE[1] QS (_ _ _ _ _ _)

_27_ _ - 2700K
30 - 3000K
35 - 3500K
_40_ _ - 4000K
CL_ _ _ _ _ _ - Custom Lumens
CW_ _ _ _ _ _ - Custom Watts
Lumen Output pg. 2

MOUNTING (_ _ _ _ _ _)

G1 - 15/16" Grid QS
G9 - 9/16" Grid QS
GS - Screw Slot Grid QS
FL - Flanged
Mounting pg. 3

VOLTAGE (_)

U - Universal *(120 thru 277V)* QS
1 - 120V QS
2 - 277V QS
3 - 347V
Voltage pg. 3

DRIVER (_ _ _)

FSD - Factory Select Driver *(1%, 0-10v)* QS
PL2 - Advance Xitanium *(1%, 0-10v)* QS
OL2 - eldoLED Optotronic *(1%, 0-10v)* QS
OL2 - eldoLED Optotronic 347v *(1%, 0-10v)*
OL5 - eldoLED Optotronic *(1%, 0-10v)*
EE1 - eldoLED ECOdrive *(1%, 0-10v)*
EE2 - eldoLED ECOdrive *(1%, 0-10v)*
LH1 - Lutron Hi-lume *(1%, EcoSystem)*
PR1 - Advance Xitanium SR
Driver pg. 4

CIRCUITING (_)

1 - Single Circuit QS
E - Emergency QS
(entire fixture)
N - Night Light QS
(entire fixture)
Circuiting pg. 4

BATTERY & EMERGENCY (_ _ _)

0 - None QS
FSB - Factory Select Battery QS
FSG - Factory Select ALCR
GI - Iota ETS DR
GB - Bodine GTD
1ILL - Iota 10W, Lithium, Self Testing QS
1PLL - Bodine 10W, Lithium, Self Testing QS
Battery and Emergency pg. 4

FINISH (_ _)

W - White QS
Finish pg. 5

FIXTURE OPTIONS[2] (_ _ _ _)

QS - QuickShip QS
TW - Through-wiring
CP - Chicago Plenum QS
AR - Air Return
AM - Antimicrobial Paint
FW6 - 6' Flex Whip QS
Fixture Options pg. 5

CONTROLS[3] (_ _ _)

DLMFC - Wattstopper DLM *(wired)*
DLMFS - Wattstopper LLLC *(wireless)*
SNSLM - Encelium SensiLUM *(wireless)*
LEVIS0 - Leviton Intellect Sensor *(wireless)*
ENL_ - Enlighted IOT *(wireless)*
ENL2_ - Enlighted 2-Wire IOT *(wireless)*
Controls pg. 6

[1]When specifying SOURCE the first _ is for specifying either 8 - 80CRI or 9 - 90CRI. The ending _ _ are for specifying output, example HO - High Output. See output charts for more information. [2]If specifying QS, QS must be used in fixture options section of part number to qualify. [3]Controls can only be used with Single Circuit (1) or Emergency Circuit (E). See Controls chart on page 5 for driver options and more information.

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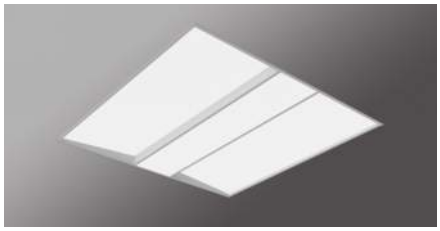
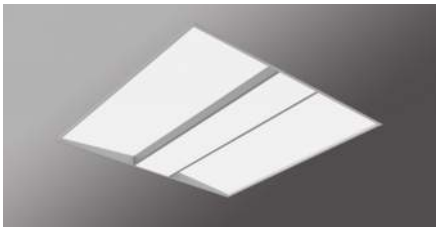
- Three piece acrylic diffuse lens
- Fully luminous housing with optimal glare control
- Highly reflective white reflectors maintain uniform lens brightness

W	S
Satine Lens with White Rails	Satine Lens with Silver Rails





Source

- Specify either 80 or 90 CRI
- Longer lead-time may apply for 90 CRI. Consult factory.
- 90 CRI = R9≥50

Custom Output- Lumens OR Wattage

CL_ _ _ _ _	Specify CRI, CCT and desired lumens (i.e. CL8351200)	*Specify lumens between standard offering listed below. Lumens are specified per color temp*
CW_ _ _ _ _	Specify CRI, CCT and desired wattage (i.e. CW94015)	*Specify watts between standard offering listed below*

80 CRI

	Color	Output	Watts	Shielding			
				W White Trim		**S** Silver Trim	
				Lumens	*LPW*	*Lumens*	*LPW*
830LO	3000K	Low	22.1	3308	150	2713	123
830MO	3000K	Middle	29.9	4410	147	3616	121
830HO	3000K	High	37.5	5484	146	4497	120
830VHO	3000K	Very High	55.9	7828	140	6419	115
835LO	3500K	Low	22.1	3322	150	2724	123
835MO	3500K	Middle	29.9	4429	148	3631	121
835HO	3500K	High	37.5	5507	147	4516	120
835VHO	3500K	Very High	55.9	7861	141	6446	115
840LO	4000K	Low	22.1	3411	154	2797	127
840MO	4000K	Middle	29.9	4547	152	3729	125
840HO	4000K	High	37.5	5655	151	4637	124
840VHO	4000K	Very High	55.9	8072	144	6619	118

90 CRI

927LO	2700K	Low	22.1	2743	124	2250	102
927MO	2700K	Middle	29.9	3657	122	2999	100
927HO	2700K	High	37.5	4548	121	3729	99
927VHO	2700K	Very High	55.9	6492	116	5323	95
930LO	3000K	Low	22.1	2810	127	2304	104
930MO	3000K	Middle	29.9	3746	125	3072	103
930HO	3000K	High	37.5	4659	124	3820	102
930VHO	3000K	Very High	55.9	6650	119	5453	98
935LO	3500K	Low	22.1	2933	133	2405	109
935MO	3500K	Middle	29.9	3909	131	3206	107
935HO	3500K	High	37.5	4862	130	3987	106
935VHO	3500K	Very High	55.9	6939	124	5690	102
940LO	4000K	Low	22.1	3011	136	2469	112
940MO	4000K	Middle	29.9	4013	134	3291	110
940HO	4000K	High	37.5	4991	133	4092	109
940VHO	4000K	Very High	55.9	7124	127	5841	104

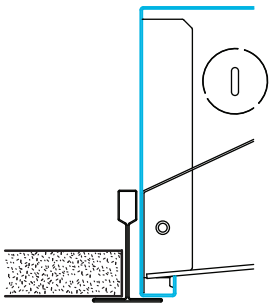
Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

Mounting

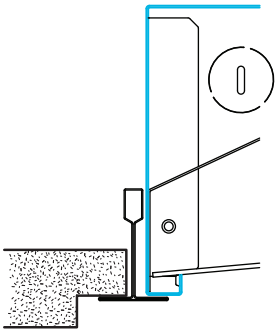
- TRAVERSE can be ordered for all grid types. See below for fixture placement in relation to the tile for each grid type
- Grid retention clips integral to housing and require mechanical attachment
- Tie off fixture to structure with retention wires
- Refer to installation instructions during installation at the jobsite
- Approved for dry/damp location
- Maximum fixture weight is 27.3lbs

G1

1" Grid Mount
Works with 15/16" grid ceiling types. See profile for fixture position in relation to ceiling grid and tile.



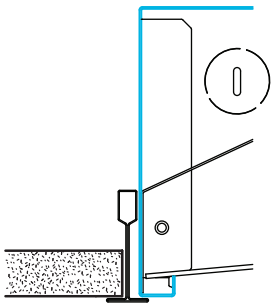
Standard Tile



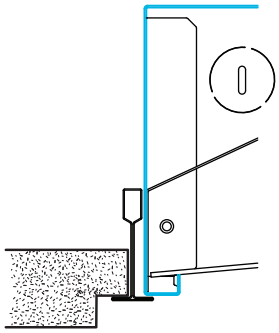
Tegular Tile

G9

9/16" Grid Mount
Works with 9/16" grid ceiling type. For tegular tile installations, fixture position will not be flush to the bottom of the tile. See tegular tile profile image below.



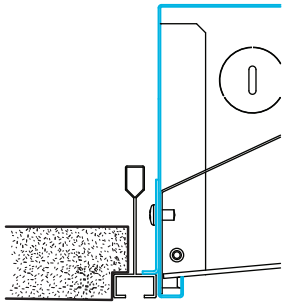
Standard Tile



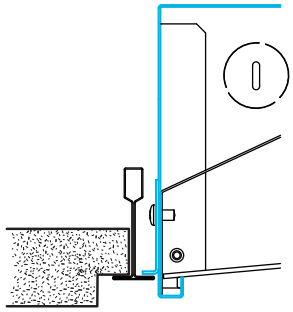
Tegular Tile

GS

Screw Slot Mounting
Works with screw slot and bolt slot grid ceiling types.



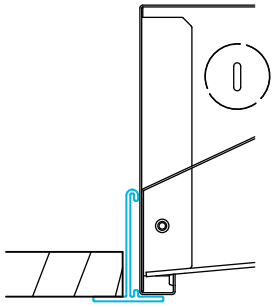
Standard Tile

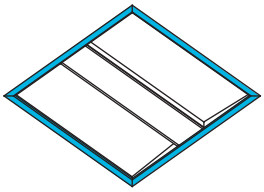


Tegular Tile

FL

Flange Kit
A separate flange kit is supplied for installations into inaccessible or drywall applications. Flange kit ships from factory uninstalled separately from fixture.





Voltage

- Some TRAVERSE configurations will not accommodate all voltage options; consult with factory

U	Universal
1	120 volt
2	277 volt
3	347 volt

Driver

- Standard Driver Option = FSD
- Driver Lifetime: 50,000 hours at 25°C ambient operating conditions
- For more Driver options, see Pinnacle Resource Guide
- Some TRAVERSE configurations will not accommodate all driver options; consult with factory

0-10V Drivers	
FSD	Factory Select Driver 1%, 0-10v
PL2	Advance Xitanium 1%, 0-10v
OL2	eldoLED Optotronic, 1%, 0-10v
OL4	eldoLED Optotronic 347v, 1% 0-10v, requires 347v option
EE1	eldoLED ECOdrive 1%, 0-10v, Logarithmic
EE2	eldoLED ECOdrive 1%, 0-10v, Linear
ES1	eldoLED SOLOdrive 0.1%, 0-10v, Logarithmic
ES2	eldoLED SOLOdrive 0%, 0-10v, Linear
OL5	eldoLED Optotronic 1%, 0-10v, AUX
DALI Drivers	
EE3	eldoLED ECOdrive .1%, DALI, Logarithmic
OD1	eldoLED Optotronic 1%, DEXAL
PR1	Advance Xitanium SR, DALI 2, Self powered link
Lutron Drivers	
LH1	Lutron Hi-lume Soft-on, Fade-to-black 1%, EcoSystem, LDE1

Circuiting

- Select fixture circuiting from options below
- Some TRAVERSE configurations will not accommodate all circuiting options; consult with factory

1	Single Circuit
E	Emergency Circuit only
N	Night Light Circuit only

Battery & Emergency

- Select battery or emergency options if required
- Battery duration is 90 minutes
- Test button is integral to fixture
- For more Battery options, see Pinnacle Resource Guide

0	No Battery
FSB	Factory Select Battery 10w, Integral Lithium
FSG	Factory Select ALCR Emergency Control Device, UNV
GI	Iota ETS-DR, Emergency Control Device, UNV
GB	Bodine GTD, Emergency Control Device, 120v or 277v
1ILL	Iota 10w, Integral Lithium, Self Testing
1PLL	Bodine 10w, Integral Lithium, Self Testing

For Approximate Battery Lumen Output

- Multiply battery wattage X fixture LPW shown on Lumen Table
- 10 (watts) x 92.3 (LPW) = 923 battery lumen output

Battery & Emergency Ordering Examples

- Single circuit, 10w integral battery — Ordering Code: 1-1PLL
- Emergency circuit only, 10w integral battery — Ordering Code: E-1PLL

Finish

- Powder-coat white painted finish

W	White

Fixture Options

- Additional options to enhance the fixture and finish of the product

QS	QuickShip
TW	Through-Wiring
CP	Chicago Plenum
AM	Antimicrobial Paint
AR	Air Return
FW6	Flex Whip 6′

Quick Ship

Shielding	Output	Mounting	Voltage	Driver	Circuiting	Battery	Finish	Options
10-Day								
W White Rails	80 CRI, All color temperatures, all lumen packages *See pg 2*	**G1** 1″ Grid **G9** 9/16″ Grid **GS** Screw Slot	**U** Universal **1** 120v **2** 277v	**FSD** Factory Select Driver *(1%, 0-10v)* **PL2** Advance Xitanium 0-10v, 1% **OL2** Osram 0-10v, 1%	**1** Single **E** Emergency **N** Night Light	**0** None **FSB** Factory Select Battery **ILL** Iota 10w **PLL** Bodine 10w	**W** White	**CP** Chicago Plenum **FW6** Flex Whip 6′ 18-gauge

Consult Factory for projects that are larger than 200 units.

Controls

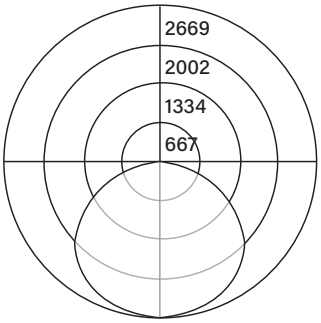
- Pinnacle Lighting offers easy to specify network control solutions that connect to an intelligent centralized system to maximize lighting energy efficiencies or integral sensors for individual fixture control
- Pinnacle Lighting fixtures ship technology ready; commissioning by others
- Controls can only be used with Single Circuit (**1**) or Emergency Circuit (**E**)
- Contact factory for any non-standard configurations for layout, placement, or EM options
- Must specify required driver in Driver section

	Solution	Components	Network/Sensor	Connection	Required Drivers	Limitations
DLMFC	Legrand Wattstopper DLM	LMFC-011	Digital Lighting Management (DLM)	Wired, two RJ45 ports	OL2	Not available with Battery
DLMFS	Legrand Wattstopper LLLC	LMFS-601-W / LMFI-111	Wireless DLM Fixture Sensor	Wireless	OD1, PR1I or 0-10v	0-10v requires interface
SNSLM	Encelium SensiLUM	EN-CLM-PIR-DD-ZB	Encelium, Daylight/PIR Occupancy	Wireless	OD1, OL5	
LEVIS0	Leviton Intellect Sensor	ZL07S-N00	Leviton Intellect, Daylight/PIR Occupancy	Wireless	OL5	
ENLI	Enlighted IOT	SU-5E-IOT	Enlighted, Daylight/PIR Occupancy	Wireless	ANY 0-10V	
ENLC	Enlighted Connected Lighting	SU-5E-CL	Enlighted, Daylight/PIR Occupancy	Wireless	ANY 0-10V	
ENL2I	Enlighted 2-Wire IOT	KIT-SU-5E-D-IOT	Enlighted, Daylight/PIR Occupancy	Wireless	OD1, PR1	
ENL2C	Enlighted 2-Wire Connected Lighting	KIT-SU-5E-D-CL	Enlighted, Daylight/PIR Occupancy	Wireless	OD1, PR1	

Photometrics

Satine Lens

Test #	F241200
Catalog #	TR24-A-835
Lumens	7633 lm
Watts	52.8 W
Efficacy	145 LPW



Candela Distribution

Vert Angle	Horizontal Angle 0	22.5	45	67.5	90
0	2666	2666	2666	2666	2666
5	2651	2644	2655	2659	2658
10	2612	2606	2618	2626	2626
15	2546	2543	2561	2574	2578
20	2458	2457	2483	2507	2517
25	2343	2349	2389	2427	2443
30	2210	2223	2279	2335	2357
35	2057	2075	2150	2222	2252
40	1887	1910	1999	2083	2118
45	1701	1728	1825	1913	1948
50	1508	1534	1630	1712	1743
55	1303	1329	1415	1483	1506
60	1097	1114	1183	1233	1248
65	882	894	941	974	982
70	675	680	706	721	726
75	465	466	478	482	482
80	274	270	271	267	263
85	111	108	94	93	89
90	6	1	7	3	8

Luminance Data (cd/sq.m)

Angle In Degrees	Average 0-Deg	Average 45-Deg	Average 90-Deg
45	3234	3469	3703
55	3053	3316	3529
65	2804	2994	3123
75	2417	2483	2503
85	1710	1455	1380

For all available IES files, please visit our website at pinnacle-ltg.com. Photometry testing in accordance to IESNA-LM-79-08 at an NVLAP accredited testing laboratory. Testing conducted at 25°C ambient conditions

Approvals & Certifications

Construction: Formed 24 gauge cold rolled steel housing. Highly reflective die-formed reflectors maintain uniform lens brightness. Wiring access on both sides and top of housing. Housing designed to maintain optimal temperature of LED diodes and driver and allow for room-side maintenance of lens, driver and LED boards.

Shielding: 3 piece diffuse lens with center spine creating a fully luminous housing with optimal glare control. Available with white or silver lens side rails.

Mounting: Designed to install into acoustical grid and inaccessible ceilings. Specify G1, G9 or GS for acoustical grid ceiling. Specify FL for inaccessible ceilings. Grid retention clips integral to housing and require mechanical attachment. Tie off fixture to structure with retention wires. Maximum fixture weight is 27.3 lbs.

LED: 25°C test environment. Lumen output/wattage has a margin of +/- 5%. Luminaire configurations tested in accordance with IES LM-79. Diodes tested in accordance with IES LM-80. Lifetime calculated using IES TM-21. Minimum lifetime greater than 60,000 hours. Lifetime Projection L70 = 275,000 hours and L90 = 83,000 hours. MacAdam 3-Step Ellipses. For all available IES files, please visit our website at pinnacle-ltg.com.

Color & Lumen Output: Not all lumen packages available. Four lumen packages available. Low (LO), Medium (MO), High (HO) and Very High (VHO). Custom outputs are available. Specify custom lumens or watts between standard offering listed on CRI, CCT & Output page. 80 CRI is available for 3000K, 3500K, and 4000K. 90 CRI is available for 2700K, 3000K, 3500K and 4000K. 90 CRI = R9≥50.

Voltage: Universal (U), 120 volt (1) and 277 volt (2) options available. Some TRAVERSE configurations will not accommodate all voltage options; consult with factory.

Driver: Standard Driver Option is Factory Select Driver 0-10V, 1% = FSD. Electronic driver, Power factor is >0.9 with a THD <20%. Driver Lifetime: 50,000 hours at 25°C ambient operating conditions. Ambient operating range: -20°F/-30°C to 87°F/30C. For more driver options, see Pinnacle Resource Guide. Some TRAVERSE configurations will not accommodate all driver options.

Circuiting: Select from single circuit (1), Emergency circuit (E) or Night Light circuit (N). Some TRAVERSE configurations will not accommodate all circuiting options, consult with factory.

Battery & Emergency: Select battery or emergency options if required. If battery or emergency option is not required, enter 0. Battery duration is 90 minutes as standard. Test button is integral to fixture. For more Battery options, see Pinnacle Resource Guide.

Finish: Powder coat white painted finish.

Controls: DLM utilizes wired network connections for digital control through switching and dimming. ENCELIUM SensiLUM sensor provides wireless control, daylight harvesting and PIR occupancy using 0-10V, DEXAL or SR LED drivers. Leviton Intellect sensor provides wireless control, daylight harvesting and PIR occupancy detection using 0-10V, DEXAL or SR LED drivers. Enlighted Smart Sensor provides multi-functionality including daylight harvesting and PIR occupancy; for IOT or Connected platform using 0-10V, DEXAL or SR LED drivers.

Labels: UL and cUL 1598 listed. LO, MO, HO and VHO lumen packages are IC Rated. Approved for dry/damp location unless otherwise noted.

Fixture Weight: 27.3 lbs maximum.

Warranty: TRAVERSE LED offered with a 5-year limited warranty. Covers LED, driver and fixture.

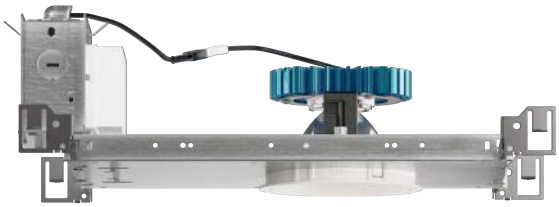
alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

NU4

4" Round Downlight Standard White

NSF AT airtight DF dead-front PR plenum rated wet rated



Trim

Trimless

Trimless Millwork

20° - 65° BEAM (Note: Specifications are subject to change without notice)		
14mm COB PERFORMANCE DATA		
LED LIGHT ENGINE	NOMINAL DELIVERED LUMENS	SYSTEM WATTAGE
10LM	990LM @30K/80CRI	9W
15LM	1485LM @30K/80CRI	12W
20LM	2095LM @30K/80CRI	17W
25LM	2540LM @30K/80CRI	21W
30LM	3090LM @30K/80CRI	26W
35LM	3580LM @30K/80CRI	31W
40LM	4180LM @30K/80CRI	37W
10LM	840LM @30K/90/CRI	9W
15LM	1260LM @30K/90/CRI	12W
20LM	1780LM @30K/90/CRI	17W
25LM	2160LM @30K/90/CRI	21W
30LM	2620LM @30K/90/CRI	26W
35LM	3040LM @30K/90/CRI	31W
40LM	3550LM @30K/90/CRI	37W
Notes	Delivered lumens based on 25D optic with no lens, (see page 2)	

12° BEAM (Note: Specifications are subject to change without notice)		
10mm COB PERFORMANCE DATA		
LED LIGHT ENGINE	NOMINAL DELIVERED LUMENS	SYSTEM WATTAGE
10LM	810LM @30K/80CRI	9W
15LM	1580LM @30K/80CRI	17W
20LM	2010LM @30K/80CRI	23W
10LM	690LM @30K/90CRI	9W
15LM	1340LM @30K/90CRI	17W
20LM	1710LM @30K/90CRI	23W
Notes	Delivered lumens based on 12D optic no lens, (see page 2)	

8° BEAM (Note: Specifications are subject to change without notice)		
6mm COB PERFORMANCE DATA		
LED LIGHT ENGINE	NOMINAL DELIVERED LUMENS	SYSTEM WATTAGE
10LM	790LM @30K/80CRI	12W
15LM	1250LM @30K/80CRI	20W
10LM	670LM @30K/90CRI	12W
15LM	1060LM @30K/90CRI	20W
Notes	Delivered lumens based on 8D optic no lens, (see page 2)	

eldoLED your product | our drive · LUTRON ADVANTAGE ACCOUNT · nLIGHT · CASAMBI

FEATURES

- 3/4" bezel regress with 1/16" micro flange
- 8° - 65° optical beam control
- UGR < 19
- Up to 110 LPW
- Glare control, specialty optics, trim options, and custom finishes available
- Microban® antimicrobial finish available on all exposed painted surfaces

DIMMING AND CONTROLS

- eldoLED flicker free 0-10V dimming to 0% and 1%
- eldoLED flicker free DALI dimming to 0% and 1%
- DMX dim to zero
- Lutron Hi-lume 1% 3-wire/Ecosystem
- Lutron athena wireless node
- Leading & trailing edge (Triac/ELV) dimming to 1%
- Casambi dimming to 1.0%
- NLight control interface dimming to 0%

CONSTRUCTION

- Lexan™ (PC) highly resistant to impact and heat (240°F)
- Optimal material for wireless signal connectivity
- Shatter proof acrylic bezel lens
- Electrocoated 16-gauge cold-rolled steel construction
- Accommodates ceiling thickness from 1/8" to 1-3/4"

LED

- 90 CRI: SDCM = 2-step MacAdam Ellipse, Lumen Maintenance: L_{70} > 66,000 hrs
- 80 CRI: SDCM = 2-step MacAdam Ellipse, Lumen Maintenance: L_{70} > 66,000 hrs

LISTING

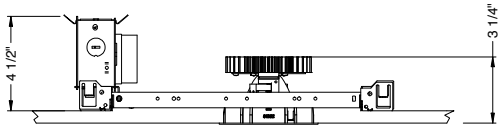
- ULus Listed to UL1598 & UL2108; cUL Listed to CSA C22.2 #250.0
- IP65 with lens - Suitable for wet locations with lens - Suitable for damp locations without lens
- Non-conductive, dead-front construction (shower approved)
- NSF/ANSI-2 with lens (Non-Food and Splash Zones)
- **Declare.** - LBC Red List Approved
- 5 Year Limited warranty

ELECTRICAL

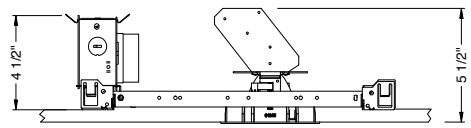
- 120V-277V, 120 only Triac / ELV
- Power factor ≥ 0.9
- 2kV driver input surge protection
- Remote and Integral (ITS) emergency test switch
- 7W, 10W (T20 CEC) and 12W EM 90min battery
- Max. ambient installation temperature 95°F (35°C)
- Low Voltage Luminaire option, see page 11.

FIXTURE HEIGHT

10LM - 30LM LOW LUMENS



35LM - 40LM HIGH LUMENS



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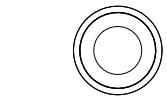
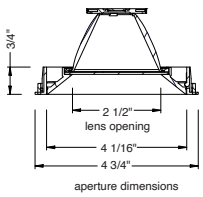
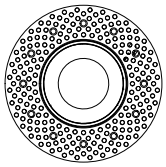


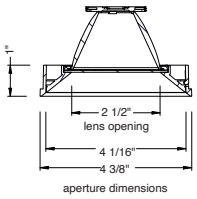
ceiling cutout
4-1/2" diameter
ceiling thickness
1/8" to 1 5/8"



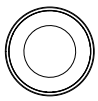
TRIMLESS



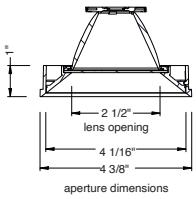
ceiling cutout
4-1/2" diameter
ceiling thickness
3/8" to 1 3/4"



MILLWORK



ceiling cutout
4-3/8" diameter
ceiling thickness
1/2" to 1 3/4"



Alphabet by Ledra Brands, Inc. | 88 Maxwell Irvine, CA 92618 | PH: 714.259.9959 FAX: 714.259.9969 | AlphabetLighting.com

101118

In a continuing effort to offer the best product possible we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product.

alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

8°- 65° BEAM ORDERING CODE

SERIES	NU4	NU4
TYPE	RD	round downlight
	RDT	round downlight trimless
	RDTMW	round downlight trimless millwork
LED	SW	standard white
DELIVERED LUMENS	10LM	990 lm
	15LM	1485 lm
	20LM	2095 lm
	25LM	2540 lm
	30LM	3090 lm
	35LM	3580 lm
	40LM	4180 lm
	Standard Configuration: 3000K 80CRI 25D, **NL**	
	Calculated Delivered Lumens = [Delivered Lumen Value] x [CCT Multiplier] x [Reflector Multiplier]	
CCT	27K	2700K
	30K	3000K
	35K	3500K
	40K	4000K

CCT	2700K		3000K		3500K		4000K	
CRI	80+	90+	80+	90+	80+	90+	80+	90+
CCT MULTIPLIER FOR LUMEN OUTPUT	0.96	0.81	1.00	0.85	1.03	0.88	1.06	0.91

CRI	80	80 CRI	
	90	90 CRI	
OPTIC & LM MULTIPLIER SEE PAGE 5, 6	8D[1]	8 degrees	(1.00)
	12D[1]	12 degrees	(1.00)
	20D	20 degrees	(0.99)
	25D	25 degrees	(1.00)
	35D	35 degrees	(0.99)
	50D	50 degrees	(0.99)
	65D	65 degrees	(0.99)
BEZEL LENS SEE PAGE 3	NL[2]	no lens	(1.00)
	CL	clear lens	(0.98)
	DL	diffused lens	(0.91)
	E[3]	elliptical beam spread	(0.92)
	HCL[4]	honeycomb louver	(0.85)
	HET	high efficiency textured lens, similar to Solite™	(0.92)
	SBL	smoothing beam lens	(0.92)
	Color lenses (amber, blue, green, red) see page 4.		
TRIM COLOR SEE PAGE 3	BK	black	
	WH	white	
	MC	matte chrome	
	BZ	bronze	
	WT	wheat	
	CC[5]	custom color, consult factory for details	
	Antimicrobial finish, add **AM** to black, white or matte chrome i.e. BKAM.		
	Not applicable to trimless option. Do not include in trimless ordering code.		
BEZEL COLOR SEE PAGE 3	BK	black	(0.98)
	WH	white	(1.00)
	MC	matte chrome	(0.99)
	BZ	bronze	(0.98)
	WT	wheat	(0.99)
	CC[5]	custom color, consult factory for details	
	Antimicrobial finish, add **AM** to black, white or matte chrome i.e. BKAM.		

8°- 65° BEAM ORDERING CODE

MOUNTING OPTIONS SEE PAGE 8, 9	NC	new construction with ceiling fitting plate
	IC[6]	insulation contact housing
	ICAT[6]	insulation contact/airtight housing
	CP[6]	chicago plenum housing
	RET	retrofit, no ceiling fitting plate
VOLTAGE	120	120V
	UNV	120V-277V
	LVL[7]	low voltage luminaire
DIMMING	DIM10	eldoLED flicker free 0-10V dimming to 1%
	DIM10Z	eldoLED flicker free 0-10V dimming to 0%
	DALI	eldoLED flicker free DALI-2 dimming to 1%
	DALIZ	eldoLED flicker free DALI-2 dimming to 0%
	DMX-RJ45	DMX control dimming to 0.1% with RJ45 connection
	DMX-WL	DMX control dimming to 0.1% with wire lead connection
	DMX-XLR	DMX control dimming to 0.1% with XLR 5pin connection
	LUT	Lutron Hi-lume Ecosystem dimming to 1%, Soft-on & Fade-to-Black
	LUTP[8]	Lutron Hi-lume Premier Ecosystem dimming to 0.1%, Soft-on & Fade-to-Black
	ELV1[9]	leading & trailing edge (Triac/ELV) dimming to 1%
	NLT	nLight control interface: standard Cat-5/RJ45 connection (female), dim to off
	CAS	Casambi control with flicker free 1% dimming
	AWNR[10]	lutron athena wireless node
	L3DA	Lutron Hi-lume 1% 3-wire/Ecosystem
	ND	No Driver Included. Customer to Supply PoE system components or order remote driver separately. Refer to POE/Remote Driver reference sheet for additional details.
ELECTRICAL OPTIONS	EM7[11]	emergency battery backup, 90 minutes at 7W to LED
	EM12[11]	emergency battery backup, 90 minutes at 12W to LED
	EM10CA20[11]	remote emergency battery backup, 90 minutes at 10W to LED, CA title 20

ADDITIONAL MOUNTING INFO

New Construction Bar Hangers (included)	Mounting Length: 14-3/4" to 26"
Extension Kit p/n: K20266 (ordered separately, 1 per fixture)	*Extends a pair of Bar Hangers* Total Mounting Length: 29" to 48"

YOUR COMPLETED ORDERING CODE

Follow the steps to specify your fixture, example:

NU4 - RD - SW - 20LM - 35K - 90 - 8D - NL - WH - WH - NC - UNV - DIM10 - EM7

NOTES

1. 8D/12D available in 10LM/15LM.
2. NL option does not meet requirements for AT/DF/WET/NSF listings. Lensing cannot be added in the field.
3. Elliptical lens not available with 8D/12D optic options. Actual beam distributions [20D= 35° x 60° , 25D= 40° x 65° , 35D= 45° x 70° , 55D= 55° x 80°]
4. HCL not available with lens.
5. Custom set up fee plus minimum quantity required per color.
6. IC/ICAT/CP not available in 40LM.
7. Must select ND dimming code, for remote driver or POE specifications see page 11.
8. LUTP not available in 25LM/30LM/40LM.
9. ELV1 (120V) not available in 10LM.
10. AWNR reference page 11 for product specifications on Athena wireless node.
11. For integrated test switch add "ITS" after emergency backup code, i.e. EM12ITS. Test switch is mounted in the bezel of the fixture.

* EldoLED and DMX uses logarithmic dimming curve as standard. For linear dimming curve, add "LIN" after dimming code, i.e. DIM10LIN.

alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

TRIM OPTIONS

TRIM/BEZEL COLORS

WH

MC

BK

BZ

WT

OPTICAL OPTIONS

- UGR calculation based on CIE 117-1995; room size: 4H X 8H, reflectance: 70/50/20;
- UGR calculation based on 15LM fixtures, unless otherwise noted.

REFLECTOR OPTIC ACCESSORY
Honeycomb Louver

OPTIC	BEAM ANGLE	UGR
8D	7.8	10.9
12D	11.3	23.5
20D	17.4	12.5
25D	22.2	13.9
35D	32.4	16.5
50D	44.9	13.4
65D	52	15.5

NL
No Lens

OPTIC	BEAM ANGLE	UGR
8D	7.8	14.2
12D	11.9	13.8
20D	18	13.6
25D	22.8	13.1
35D	36.2	14.5
50D	49.2	18.3
65D	64.5	18.8

CL
Clear Lens

OPTIC	BEAM ANGLE	UGR
8D	7.9	13.7
12D	12.1	13.3
20D	18	13.3
25D	22.8	12.8
35D	36.2	14.2
50D	49.2	18.1
65D	64.6	18.5

DL
Diffused Lens

OPTIC	BEAM ANGLE	UGR
20D	39.4	19.5
25D	42.4	19.8
35D	50.6	20.8
50D	56.7	21.4
65D	66.7	23.3

HET
High Efficiency Textured Lens

OPTIC	BEAM ANGLE	UGR
20D	22.5	13.8
25D	27	14
35D	38.8	15.8
50D	49.8	16.5
65D	60.4	19.5

SBL
Smoothing Beam Lens

OPTIC	BEAM ANGLE	UGR
8D	10.2	12.8
12D	13.2	12.9
20D	19.3	13
25D	24.3	13.1
35D	37.2	14.8
50D	51.2	15.6
65D	62.2	18.8

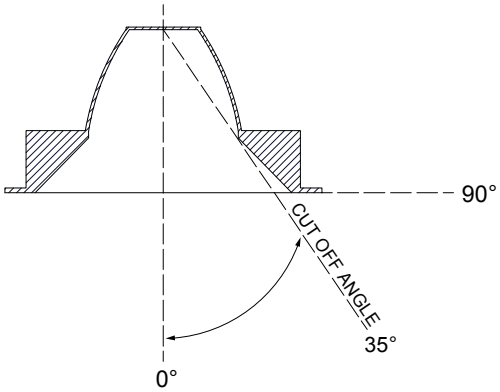
GLARE CONTROL

CUT-OFF ANGLE

Visual comfort is achieved with a lower cut-off angle due to improved glare control. The smaller the cut-off angle, the easier it is on the eye.

Alphabet downlights have been thoughtfully engineered to eliminate glare while still delivering functional illumination.

- Cutoff angle of CL is 35 degrees;



alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

TRIM OPTIONS

TRIM/BEZEL COLORS

WH

MC

BK

BZ

WT

OPTICAL OPTIONS

- UGR calculation based on CIE 117-1995; room size: 4H X 8H, reflectance: 70/50/20;
- UGR calculation based on 15LM fixtures, unless otherwise noted.

AMBER

OPTIC	MULTIPLIER	BEAM SPREAD
20D	0.485	18°
25D	0.484	22°
35D	0.485	35°
50D	0.48	50°
65D	0.473	60°

AVERAGE LUMENS:2000LM 1880 CCT

RED

OPTIC	MULTIPLIER	BEAM SPREAD
20D	0.04	18°
25D	0.04	22°
35D	0.04	35°
50D	0.04	50°
65D	0.038	60°

AVERAGE LUMENS: 168LM

GREEN

OPTIC	MULTIPLIER	BEAM SPREAD
20D	0.202	18°
25D	0.202	22°
35D	0.204	35°
50D	0.2	50°
65D	0.196	60°

AVERAGE LUMENS: 850LM

BLUE

OPTIC	MULTIPLIER	BEAM SPREAD
20D	0.051	18°
25D	0.051	22°
35D	0.053	35°
50D	0.05	50°
65D	0.049	60°

AVERAGE LUMENS: 210LM

Add AM / BL / GR / RD to bezel lens ordering code section.
Example: NU4 - RD - SW - 10LM - 30K - 80 - 35D - **BL** - WH - WH - NC - UNV - DIM

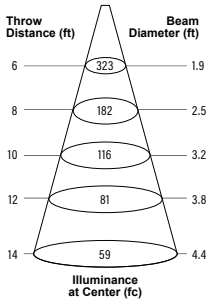
alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

PHOTOMETRIC DATA

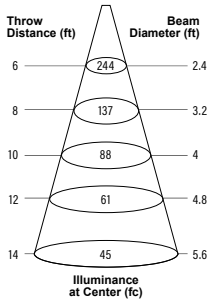
20LM CCT MULTIPLIERS		
	80CRI	90CRI
2700K	0.96	0.81
3000K	1	0.85
3500K	1.03	0.88
4000K	1.06	0.91
FC Formula = CBCP / Distance^2		

20D 18° NO LENS



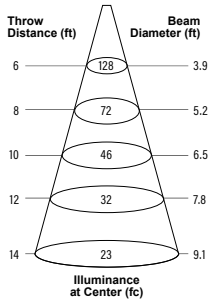
WATTS: 17.2	LPW: 121.4
LUMENS: 2088	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	11622
5	10517
15	2170
25	862
35	401
45	3

25D 23° NO LENS



WATTS: 17.2	LPW: 122.1
LUMENS: 2099	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	8779
5	7589
15	2759
25	940
35	372
45	2

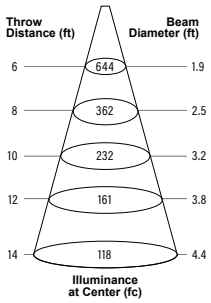
35D 36° NO LENS



WATTS: 17.2	LPW: 120.6
LUMENS: 2074	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	4594
5	4283
15	2845
25	1317
35	435
45	10

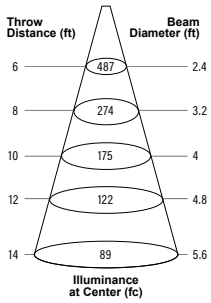
40LM CCT MULTIPLIERS		
	80CRI	90CRI
2700K	0.96	0.81
3000K	1	0.85
3500K	1.03	0.88
4000K	1.06	0.91
FC Formula = CBCP / Distance^2		

20D 18° NO LENS



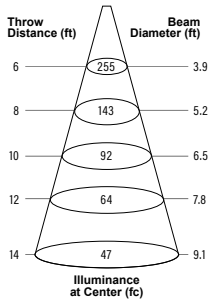
WATTS: 37.3	LPW: 111.7
LUMENS: 4165	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	23188
5	20984
15	4329
25	1719
35	799
45	5

25D 23° NO LENS



WATTS: 37.3	LPW: 112.3
LUMENS: 4189	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	17516
5	15142
15	5504
25	1876
35	742
45	4

35D 36° NO LENS



WATTS: 37.3	LPW: 110.9
LUMENS: 4138	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	9166
5	8545
15	5676
25	2627
35	868
45	19

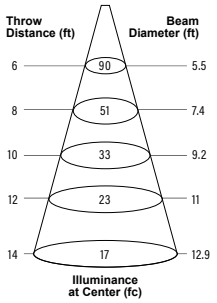
alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

PHOTOMETRIC DATA

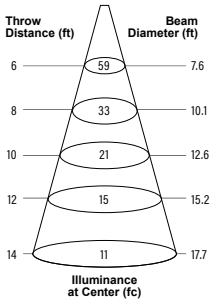
20LM CCT MULTIPLIERS		
	80CRI	90CRI
2700K	0.96	0.81
3000K	1	0.85
3500K	1.03	0.88
4000K	1.06	0.91
FC Formula = CBCP / Distance^2		

50D 49° NO LENS



WATTS: 17.2	LPW: 121.2
LUMENS: 2085	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	3253
5	3231
15	2606
25	1591
35	450
45	13

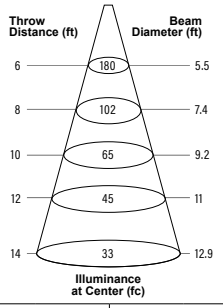
65D 65° NO LENS



WATTS: 17.2	LPW: 120.9
LUMENS: 2080	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	2103
5	2101
15	1990
25	1520
35	779
45	144

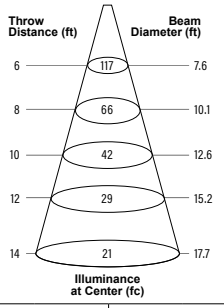
40LM CCT MULTIPLIERS		
	80CRI	90CRI
2700K	0.96	0.81
3000K	1	0.85
3500K	1.03	0.88
4000K	1.06	0.91
FC Formula = CBCP / Distance^2		

50D 49° NO LENS



WATTS: 37.3	LPW: 111.5
LUMENS: 4160	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	6491
5	6446
15	5200
25	3175
35	898
45	25

65D 65° NO LENS



WATTS: 37.3	LPW: 111.2
LUMENS: 4150	CCT: 3000K
INTENSITY	
DEGREE	CANDELA
0	4195
5	4191
15	3971
25	3033
35	1555
45	288

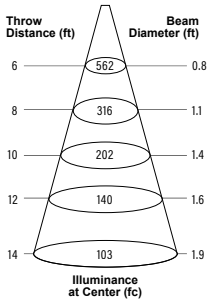
alphabet

PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

PHOTOMETRIC DATA

10LM CCT MULTIPLIERS		
	80CRI	90CRI
2700K	0.96	0.81
3000K	1	0.85
3500K	1.03	0.88
4000K	1.06	0.91
FC Formula = CBCP / Distance^2		

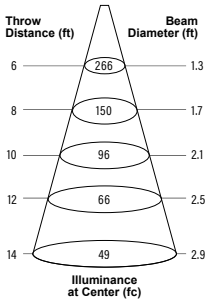
8D 7.8° NO LENS



WATTS: 12	LPW: 66
LUMENS: 792	CCT: 3000K

INTENSITY	
DEGREE	CANDELA
0	20223
5	6477
15	368
25	287
35	170
45	0

12D 12° NO LENS

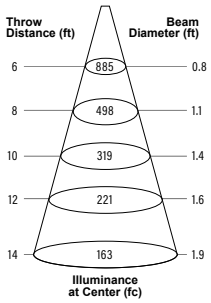


WATTS: 8.7	LPW: 92.8
LUMENS: 807	CCT: 3000K

INTENSITY	
DEGREE	CANDELA
0	9574
5	6065
15	532
25	299
35	155
45	0

20LM CCT MULTIPLIERS		
	80CRI	90CRI
2700K	0.96	0.81
3000K	1	0.85
3500K	1.03	0.88
4000K	1.06	0.91
FC Formula = CBCP / Distance^2		

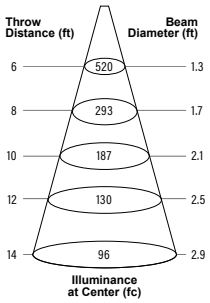
8D 7.8° NO LENS



WATTS: 20	LPW: 62.4
LUMENS: 1248	CCT: 3000K

INTENSITY	
DEGREE	CANDELA
0	31866
5	10206
15	579
25	452
35	269
45	1

12D 12° NO LENS



WATTS: 17	LPW: 92.9
LUMENS: 1579	CCT: 3000K

INTENSITY	
DEGREE	CANDELA
0	18725
5	11861
15	1041
25	585
35	303
45	0

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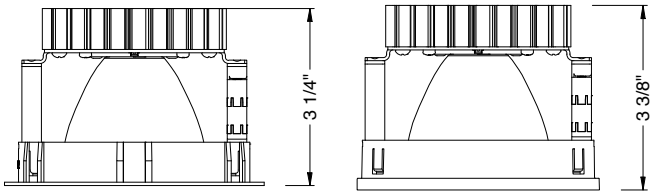
PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

MOUNTING OPTIONS

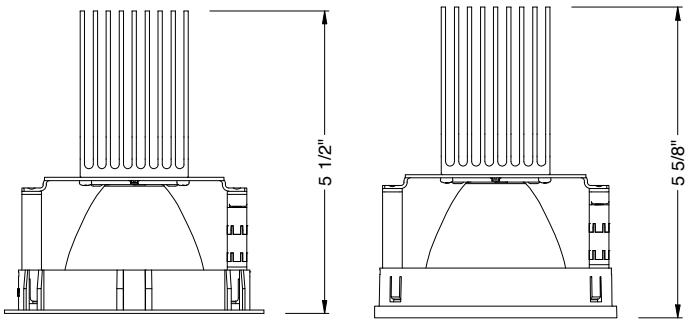
FIXTURE HEIGHT

10M - 30LM CONFIGURATION



TRIMMED TRIMLESS & MILLWORK

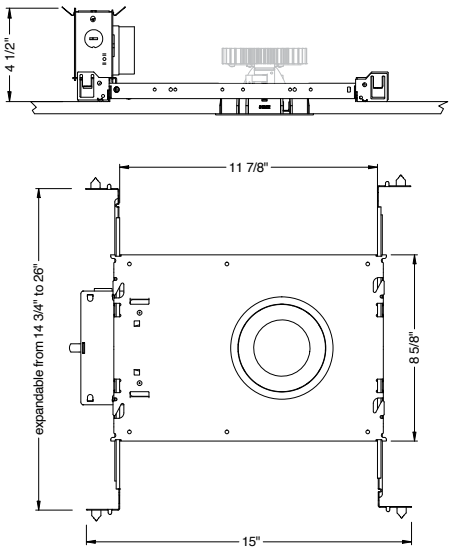
35M - 40LM CONFIGURATION



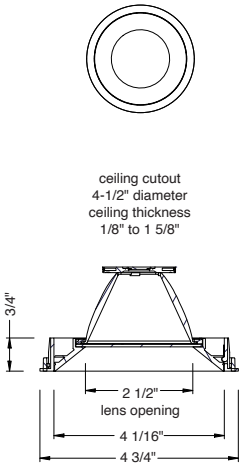
TRIMMED TRIMLESS & MILLWORK

NC - NEW CONSTRUCTION

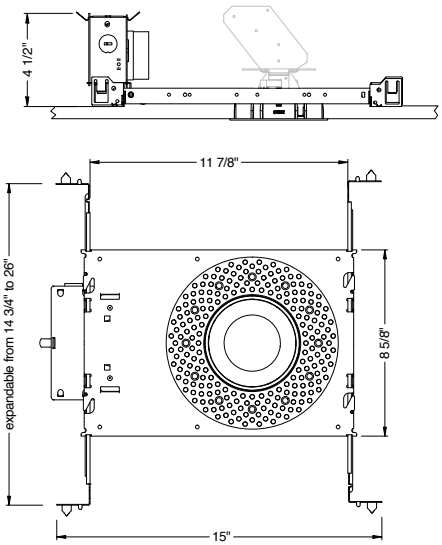
TRIM



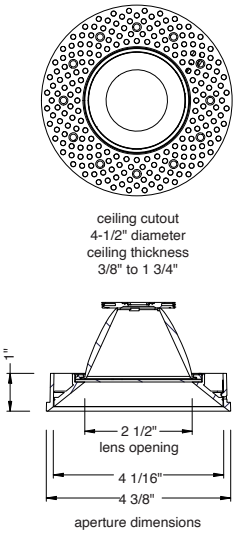
TRIM



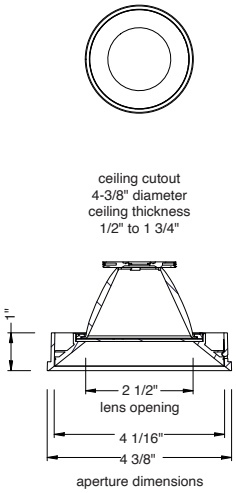
TRIMLESS



TRIMLESS



TRIMLESS/MILLWORK



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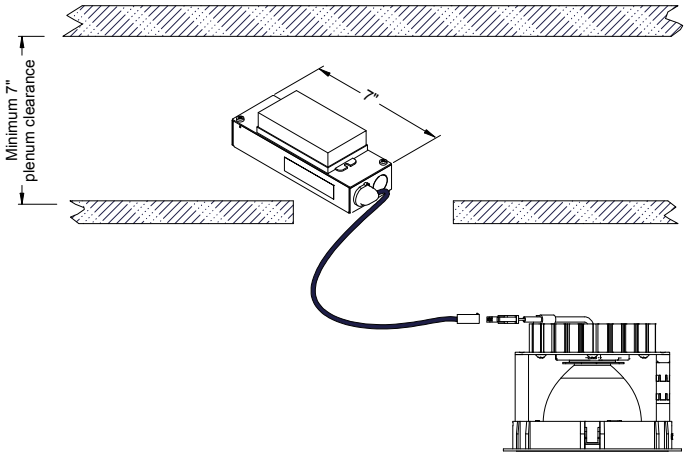
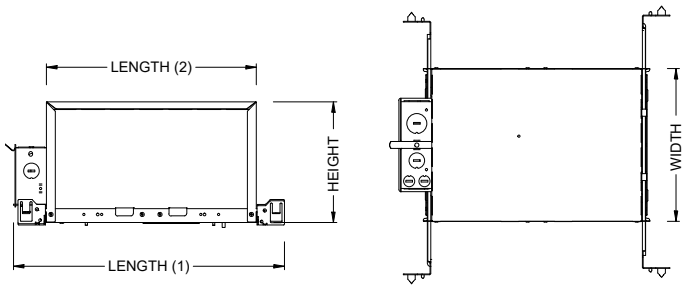
PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

MOUNTING OPTIONS (CONTINUED)

RET - RETRO
TRIM/TRIMLESS



IC - INSULATION CONTACT HOUSING
ICAT - INSULATION CONTACT / AIR TIGHT
CP - CHICAGO PLENUM



BOX SIZE	L 1	L 2	W	H
A	15 - 7/16"	11 - 3/4"	8 - 1/2"	6 - 3/4"
B	18 - 1/4"	14 - 7/8"	12 - 1/8"	11 - 1/4"

RATINGS / CERTIFICATIONS	NC	RET	IC	ICAT	CP
TYPE NON-IC	✔	✔			
TYPE IC			✔	✔	✔
CHICAGO PLENUM (CCEA)					✔
SUITABLE FOR AIR HANDLING PLENUMS	✔	✔	✔	✔	✔
REDUCED AIRFLOW (WITH LENS) ASTM E283	✔	✔	✔	✔	✔

CEILING THICKNESS	
FIXTURE TYPE	MOUNTING TYPE
	NC, IC, ICAT, CP, RET
	STANDARD CEILING THICKNESS
TRIM	1/8" to 1-5/8"
TRIMLESS	3/8" to 1-3/4"
MILLWORK (TRIMLESS)	1/2" to 1-3/4"

BOX TYPE / LUMEN OUTPUT - NARROW BEAM (8°-12°)						
LUMEN OUTPUT	BOX - A			BOX - B		
	IC	ICAT	CP	IC	ICAT	CP
10LM	✔	✔	✔			
15LM	✔	✔	✔			
20LM				✔	✔	✔

BOX TYPE / LUMEN OUTPUT - STANDARD BEAMS (20° - 65°)						
LUMEN OUTPUT	BOX - A			BOX - B		
	IC	ICAT	CP	IC	ICAT	CP
10LM	✔	✔	✔			
15LM	✔	✔	✔			
20LM	✔	✔	✔			
25LM	✔	✔	✔			
30LM	✔	✔	✔			
35LM				✔	✔	✔
40LM						

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PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

BATTERY OPTIONS

EMERGENCY BATTERY

IOTA's ILB Battery Backups are UL Listed LED emergency drivers that allow the same LED fixture to be used for both normal and emergency operation. In the event of a power failure, the ILB switches to the emergency mode and operates the existing fixture for 90 minutes. The unit contains a battery, charger, and converter circuit in a single can. The Constant Power design of the ILB maintains the output wattage to the LED array even as the system voltage diminishes. UL 924 Listed for U.S. and Canada. UL 1310 Certified, Output Class 2 Compliant. Includes single-piece TBTS test switch and charge indicator accessory kit. For use with switched and unswitched fixtures, and includes Two-wire universal AC input. Meets or exceeds all National Electric Code and Life Safety Code Emergency Lighting Requirements. Rated for use in Plenum, Damp Location, Recessed Type IC, and Enclosed and Gasketed Luminares.

REMOTE TEST SWITCH

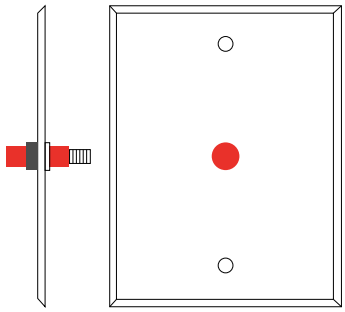
The Remote Test Switch may be mounted adjacent to the LED Fixture by others.

EMERGENCY BATTERY ACCESS

Above ceiling access is required for service. An access panel in the ceiling (or other form of access) adjacent to the installation location of the Emergency Battery is required.

REMOTE LOCATION

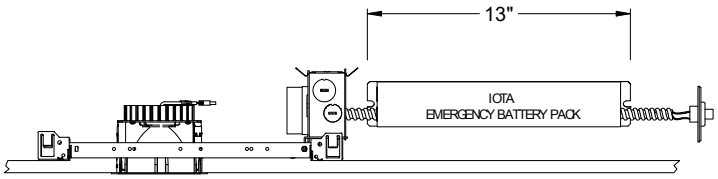
Maximum remote mounting distance of the emergency driver shall be 50 feet. Remote location wiring provided by others. Follow all Local and National Electric/ Building Codes.



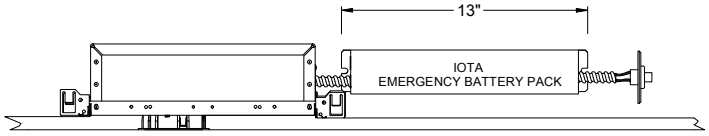
Remote Test Switch

EM MODE OUTPUT (DELIVERED LUMENS)			
LUMEN ORDERING CODE	EM7	EM10	EM12
ALL OPTIONS (10LM TO 30LM)	820LM	1200LM	1480LM
Notes: Based on 30K, 80CRI			

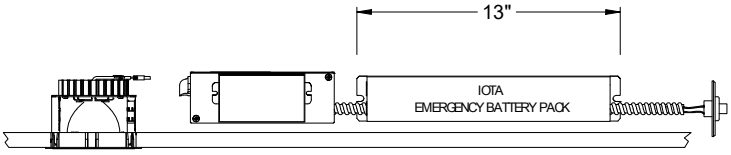
NC - NEW CONSTRUCTION
WITH EM BATTERY (REMOTE TEST SWITCH)



IC / ICAT / CP - INSULATION CONTACT HOUSING
WITH EM BATTERY (REMOTE TEST SWITCH)

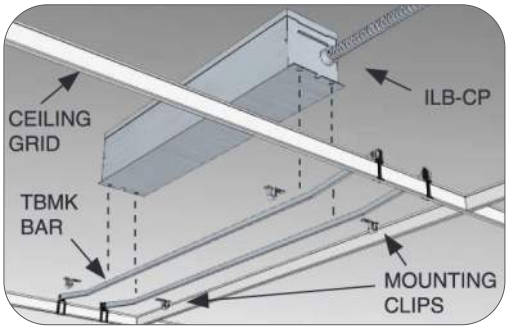


RET - RETROFIT
WITH EM BATTERY (REMOTE TEST SWITCH)



Accessory

76066 Optional T-Grid Mounting Kit[1]



1. Can be used with any of the Emergency Battery Backups. Must be ordered as a separate line item.

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PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

LOW VOLTAGE OPTIONS

20° - 65° BEAM
(Note: Specifications are subject to change without notice)

14mm COB PERFORMANCE DATA

LED LIGHT ENGINE	NOMINAL DELIVERED LUMENS	DRIVE CURRENT	LED WATTAGE
10LM	990LM @30K/80CRI	250mA	9W
15LM	1485LM @30K/80CRI	300mA	11W
20LM	2095LM @30K/80CRI	425mA	15.5W
25LM	2540LM @30K/80CRI	525mA	19W
30LM	3090LM @30K/80CRI	650mA	23.5W
35LM	3580LM @30K/80CRI	800mA	29W
40LM	4180LM @30K/80CRI	900mA	32.5W
10LM	840LM @30K/90/CRI	250mA	9W
15LM	1260LM @30K/90/CRI	300mA	11W
20LM	1780LM @30K/90/CRI	425mA	15.5W
25LM	2160LM @30K/90/CRI	525mA	19W
30LM	2620LM @30K/90/CRI	650mA	23.5W
35LM	3040LM @30K/90/CRI	800mA	29W
40LM	3550LM @30K/90/CRI	900mA	32.5W
Notes	Delivered lumens based on 25D optic with no lens, (see page 2)		

12° BEAM
(Note: Specifications are subject to change without notice)

10mm COB PERFORMANCE DATA

LED LIGHT ENGINE	NOMINAL DELIVERED LUMENS	DRIVE CURRENT	LED WATTAGE
10LM	810LM @30K/80CRI	250mA	9W
15LM	1580LM @30K/80CRI	300mA	11W
20LM	2010LM @30K/80CRI	400mA	14.5W
10LM	690LM @30K/90CRI	250mA	9W
15LM	1340LM @30K/90CRI	300mA	11W
20LM	1710LM @30K/90CRI	400mA	14.5W
Notes	Delivered lumens based on 12D optic no lens, (see page 2)		

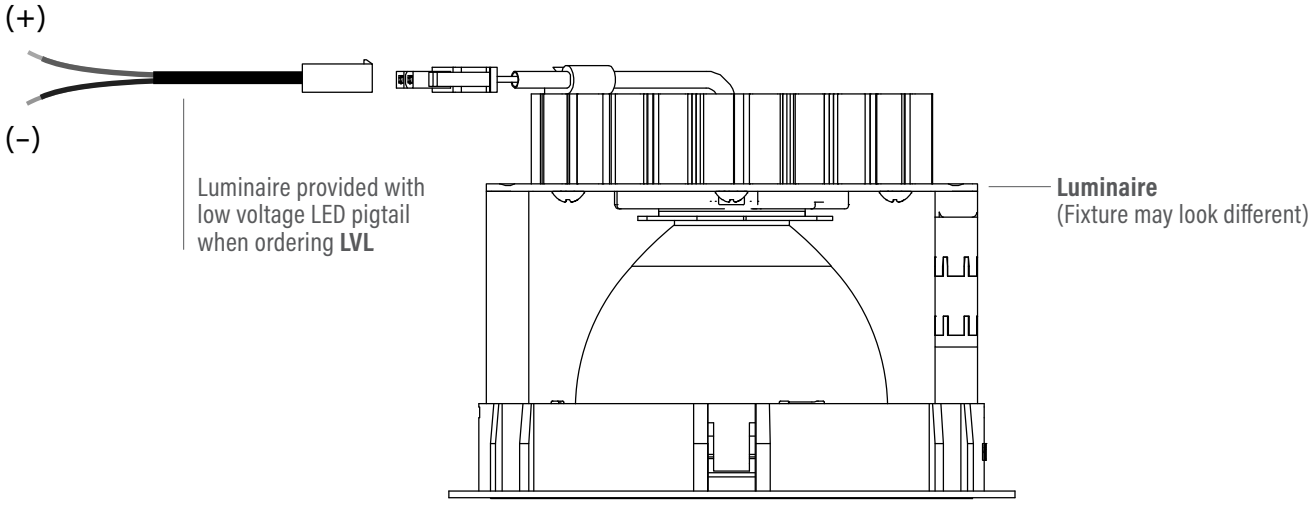
8° BEAM
(Note: Specifications are subject to change without notice)

6mm COB PERFORMANCE DATA

LED LIGHT ENGINE	NOMINAL DELIVERED LUMENS	DRIVE CURRENT	LED WATTAGE
10LM	790LM @30K/80CRI	225mA	8.5W
15LM	1250LM @30K/80CRI	350mA	13W
10LM	670LM @30K/90CRI	225mA	8.5W
15LM	1060LM @30K/90CRI	350mA	13W
Notes	Delivered lumens based on 8D optic no lens, (see page 2)		

NOMINAL LED VOLTAGE: 36VDC

Customer to order CC Remote Driver separately or POE Node by others.



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PROJECT INFORMATION			
JOB NAME		TYPE	
ORDERING CODE			

AWNR OPTIONS

Athena Wireless Node

The Athena wireless node is a radio frequency (RF) device that enables simple, digital control of individual light fixtures in an Athena control system.

OEM ADVANTAGE LUTRON

Athena Wireless Node RF

AWNR

Plenum rated and can be installed above the ceiling for wireless control of a fixture without any impact on fixture aesthetics.

FEATURES

- Enables individual, wireless control of each fixture in an Athena control system. Accommodates zone and control changes without rewiring.
- Installed at factory – no wiring required on-site. Fixture is ready to communicate wirelessly once power is connected.
- All drivers on the link are controlled as a single zone.

REGULATORY APPROVALS

- cULus Listed (UL916)
- Complies with requirements for use in other spaces used for environmental air (plenums) per NEC® 2014 300.22(C)(3).
- FCC compliant with the limits for a Class B digital device.
- IC (Industry Canada)
- ANSI C137.1 0–10 V- Electronic Off

POWER / LOAD

- IEC SELV/NEC® Class 2
- 1 Watt

ENVIRONMENTAL

- Ambient operating temperature (immediate vicinity of Athena wireless node): **32 °F to 131 °F** (0 °C to 55 °C), 0% to 90% humidity.

BATTERY OPTIONS

- For EM options please consult factory.

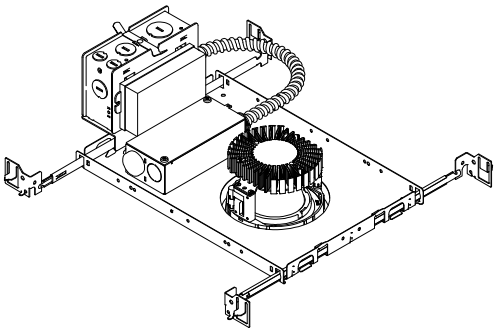
Note: Default behavior prior to programming

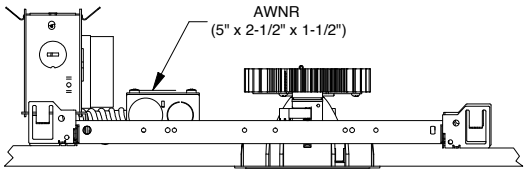
- Light level 100%
- Athena wireless node performs an unprogrammed startup sequence on every power up until the device is added to an Athena system.
- Each Athena wireless node should be installed within 25 ft (7.62 m) of two or more Athena wireless nodes or other Clear Connect – Type X devices.
- For Chicago plenum installations, the Athena wireless node may not be installed in the plenum space. It must be installed in the occupied space.

For servicing the driver/j-box, access above ceiling is required. (NC Mounting)

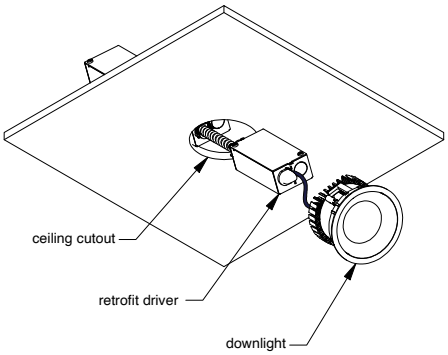
IC/ICAT/CP not available in AWNR.

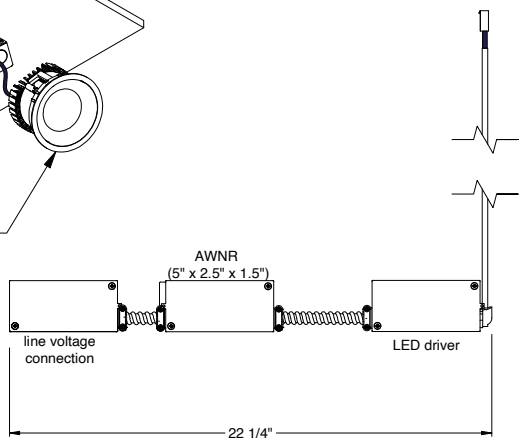
NC - NEW CONSTRUCTION





RET - RETRO FIT





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LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

LED Linear

CLX

24", 36", 48" and 96" Lengths

Flat Diffuse Lens

Round Diffuse Lens

Wide Diffuse Lens

CLX with Reflector

FEATURES & SPECIFICATIONS

INTENDED USE — The CLX is a linear lighting solution that is available in multiple lengths, lumen packages and distributions. Designed for versatility, the CLX can address virtually any indoor lighting need. The CLX is also offered in standard and high efficacy configurations and capable of being continuous row mounted or installed as a stand-alone fixture. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Channel and cover are formed from code-gauge cold-rolled steel. Housing and lens endcaps are injection molded plastic to provide a more architectural look and feel. The endcaps come standard with a 7/8" knock out for continuous mounting but can be ordered without.

Finish: Paint options include high-gloss, baked white polyester (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). Five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Offered with acrylic lens and less lens configurations. Provides a choice of optical distributions including, wide, narrow, and aisle.

Models with wide diffuse lens provide up to 12% uplight. Please check the IES file for specific uplight value.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 9.) Electronic LED driver is multi-volt input and 0-10V dimming standard (see Operational Data on page 6 for actual wattage consumption). This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided. Color Variation within 3-step MacAdam ellipse (3SDCM).

L70>100,000 hours at 25˚C.

LEDs provide nominal 80 CRI or 90 CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,500 lumens per foot.

INSTALLATION — Fixture may be ceiling or wall mounted (with or without THCLX hanger or angle mounted with CLXANGBKT), pendant or stem mounted with appropriate mounting options.

WARNING — Removing the lens and opening the fixture during installation exposes the LEDs, putting them at risk for damage.

If you plan to surface mount the fixture, we recommend using the THCLX. This eliminates the need to open the fixture.

If you plan to continuous row mount, we recommend using the PLR wiring harness option. This eliminates the need to open the fixture.

Damage to the LEDs caused during installation will not be covered under the warranty.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -4°F (-20°C) and 104°F (40°C). Optional High Ambient (HA) ranging to 122°F(50°C) available on certain lumen packages (See ambient temperature chart for additional information).
DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

GOVERNMENT PROCUREMENT — BAA – Product with the BAA option qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product with the BAA option also qualifies as manufactured in the United States under DOT Buy America regulations.
BABA – Build America Buy America: Product with the BAA option also qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

Stock configurations are offered for shorter lead times:

Stock Part Number	UPC
CLX L48 3000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525816
CLX L48 3000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525885
CLX L48 5000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525939
CLX L48 5000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525908
CLX L96 6000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525861
CLX L96 6000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525915
CLX L96 10000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525922
CLX L96 10000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525830
CLX L48 3000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525960
CLX L48 3000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525892
CLX L48 5000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525854
CLX L48 5000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525946
CLX L96 6000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525878
CLX L96 6000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525823
CLX L96 10000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525953
CLX L96 10000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525847

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.
All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specifications for chromatic consistency – including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing visit www.acuitybrands.com/aplus.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

Design Select options indicated by this color background.

ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

Example: CLX L48 5000LM SEF WDL MVOLT GZ10 40K 80CRI WH

Series	Length	Nominal lumens	Performance package	Louver	Lens
CLX LED linear	L24 24"	1500LM 1,500 lumens	SEF Standard efficiency ‡	(Blank) Less louver	L/Lens Less lens
		2000LM 2,000 lumens	HEF Premium efficiency ‡	SBLW Straight blade louver, white ‡	FDL Flat diffuse ‡
		2500LM 2,500 lumens		SBLMB Straight blade louver, matte black ‡	RDL Round diffuse ‡
		3500LM 3,500 lumens		SBLGV Straight blade louver, galvanized ‡	WDL Wide diffuse ‡
		4500LM 4,500 lumens		SBLSKGY Straight blade louver, smoke gray ‡	
		5000LM 5,000 lumens			
	L36 36"	2250LM 2,250 lumens			
		3000LM 3,000 lumens			
		3750LM 3,750 lumens			
		5250LM 5,250 lumens			
		6750LM 6,750 lumens			
		7500LM 7,500 lumens			
	L48 48"	3000LM 3,000 lumens			
		4000LM 4,000 lumens			
		5000LM 5,000 lumens			
		7000LM 7,000 lumens			
		9000LM 9,000 lumens			
		10000LM 10,000 lumens			
	L96 96"	6000LM 6,000 lumens			
		8000LM 8,000 lumens			
		10000LM 10,000 lumens			
		14000LM 14,000 lumens			
		18000LM 18,000 lumens			
		20000LM 20,000 lumens			

Distribution	Voltage		Driver ‡	Glare Reflector	Color temperature	Coloring rendering index
(Blank) General	MVOLT 120-277V ‡	277 277V	GZ1 Generic 0-10V, dims to 1% ‡	(blank) No reflectors	30K 3000 K	80CRI 80 CRI
ND Narrow ‡	120 120V	347 347V ‡	GZ10 Generic 0-10V, dims to 10% ‡	LUGR Reflectors for additional glare reduction ‡	35K 3500 K	90CRI 90 CRI
WD Wide ‡	208 208V ‡	480 480V ‡	EZ1 eldoLED 0-10V, dims to 1% ‡		40K 4000 K	
AD2 Aisle, 24° off center ‡	240 240V ‡				50K 5000 K	

Options

E10W	10W Emergency battery pack, constant power, Certified in CA Title 20 MAEDBS, User selectable Self-Diagnostic, AC Activate with Integral Test Switch [LINK] ‡
E10WSTAR	Emergency battery pack, Enabled with STAR ‡
BGTD	Generator transfer device, not available with E10W ‡
OCS	5', 18/3 Reloc selectable One Pass cable (fixture will bear dry location label) ‡
HA	High ambient, for use in ambient temperatures up to 50°C ‡
EPNKO	Decorative endplate, no knock out ‡
OUTCTR	Wiring leads pulled through back center of fixture ‡
OUTEND	Wiring leads pulled through end of fixture ‡
Cord Sets: ‡	
CS1W	6' Staight blade plug, 120V ‡
CS3W	NEMA twist-lock plug, 120V ‡
CS7W	Staight blade plug, 277V ‡
CS11W	NEMA twist-lock plug, 277V ‡
CS25W	NEMA twist-lock plug, 347V ‡
CS97W	NEMA twist-lock plug, 480V ‡
CS93W	600V SEOOW white cord, no plug (no voltage required)
CS6WG16STOWD5D	6' white cord, 16/5, no plug, includes low voltage dimming wires (no voltage required) ‡

PLR___	Plug-in wiring, see page 9 for ordering information
PLR1G	Plug-in wiring, single circuit, Ground
PLR1LVG	Plug-in wiring, single circuit, low-voltage dimming, Ground ‡
RRL___	RELOC®-ready luminaire. See page 14 for ordering information
SPD	Surge protection device, provides up to 6kV protection ‡
BAA	Buy America(n) Act and/or Build America Buy America Qualified
nLight® Wireless:	
NLTAIR2 RES7	nLight AIR Generation 2 enabled PIR integral occupancy sensor with automatic dimming photocell ‡
NLTAIR2 RES7EM	nLight AIR Generation 2 enabled PIR integral occupancy sensor with automatic dimming photocell and UL924 Emergency operation, via power interrupt detection ‡
NLTAIR2 RES7PDT	nLight AIR Generation 2 enabled dual technology integral occupancy sensor with automatic dimming photocell ‡
NLTAIR2 RES7PDTEM	nLight AIR Generation 2 enabled dual technology integral occupancy sensor with automatic dimming photocell and UL924 Emergency operation, via power interrupt detection ‡
NLTAIR2 RIO	No sensor control ‡
NLTAIR2 RIOEM	No sensor, Control Input function only and UL924 Emergency operation, via power interrupt detection ‡

nLight® Wired:	
N100	nLight® without lumen management
N100EMG	nLight® without lumen management For use with generator supply EM power ‡
NES7	nLight® nES 7 PIR integral occupancy sensor ‡
NESPDT7	nLight® nES PDT 7 dual technology integral occupancy control ‡
NES7ADCX	nLight® nES 7 ADCX PIR integral occupancy sensor with automatic dimming photocell ‡
NESPDT7ADCX	nLight® nES PDT 7 dual technology integral occupancy sensor with automatic dimming photocell ‡
Individual controls: ‡	
MSD7	PIR integral occupancy sensor
MSDPDT7	PDT 7 dual technology integral occupancy control
MSD7ADC	PIR integral occupancy sensor with automatic dimming control photocell
MSDPDT7ADC	PDT integral occupancy sensor with automatic dimming control photocell

Finish

WH	White
GALVW	Galvanized with white lens end caps
GALVB	Galvanized with black lens end caps
MB	Matte black
SKGYW	Smoke gray with white lens end caps
SKGYB	Smoke gray with black lens end caps

See Accessories and footnotes on next page

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Accessories: *Order as separate catalog number.*

Mounting:

ZACVH M100	Adjustable 10' aircraft cable with Y hanger (1 pair)
ZAC120	One adjustable aircraft cable with canopy 120", white
ZACFP120	One adjustable aircraft cable with feed (3 conductor) and canopy, 120", white
ZACFPD120	One adjustable aircraft cable with feed (5 conductor) and canopy 120", white
ZAC240	One adjustable aircraft cable with canopy 240", white
ZACFP240	One adjustable aircraft cable with feed (3 conductor) and canopy, 240", white
ZACFPD240	One adjustable aircraft cable with feed (5 conductor) and canopy 240", white

SQ_	Swivel stem hanger (specify length in 2" increments up to 48") Ships White
THCLX ___	Tong hanger (Must specify color) (one pair) ‡
CLXANGBKT ____	Angle bracket, (Must specify color) (one pair) ‡
HC36 M12	Hanger chain, 36" (1 pair)

Wireguards:

WGCLX24 ___	24" wireguard qty 1, (Must specify color) ‡
WGCLX36 ___	36" wireguard qty 1, (Must specify color) ‡
WGCLX48 ___	48" wireguard qty 1, (Must specify color) ‡
WGCLX48 ___ J2	48" wireguard qty 2, (Must specify color) ‡
WGCLX48 ___ J25	48" wireguard qty 25, (Must specify color) ‡
WGCLX48 ___ J50	48" wireguard qty 50, (Must specify color) ‡

‡ Option Value Ordering Restrictions

Option value	Restriction
347V, 480V	Voltage selected utilizes a step-down transformer. Not available with L24 when ordered with N100. Not available with E10W or BGTD options.
BGTD	Not available with MVOLT, 208V or 240V. Not available with HA. Available with L48 or L96 only. Not available with E10W option. Not available with 208 or 240V. Not available Individual controls, NLight Wired, or NLight Wireless options.
CS1W, CS3W, CS7W, CS11W, CS25W, CS963W, CS97W	Not available with BGTD option. Must specify voltage. Not available with PLR options.
CS6WG16STOWD5D	Not available with Individual controls, nLight wired networking, nLight wireless networking, nLight wireless zone control options.
Driver	When continuous row mounting, fixtures must all have the same driver selection.
E10W	Not available with OUTCR, Not available with HA. Not available with 347V or 480V. Not available with BGTD option. Requires SPD option. Not available with L24 or L36. Not available with L48 in combination with N100.
E10WSTAR	Not available with OUTCR. Not available with HA. Not available with 347V or 480V. Not available with BGTD option. Requires SPD option. Not available with L24 or L36. Not available with L48 in combination with N100.
EPNKO	Not available OUTEND.
EZ1	Not available with HA option. Not available with 5000LM, 7500LM.
FDL, RDL, WDL	Only available with general distribution. Not available with CLXRN accessories.
GZ1, GZ10	Not available with Individual controls, nLight wired networking, nLight wireless networking, nLight wireless zone control options.
HA	Not available with L24, L26. Not available with BGTD option. Not available with EZ1. Only available with L48 3000/4000/5000LM and L96 6000/8000/10000LM.
HEF	Not available with L48 3000LM and L96 6000LM
LUGR	Not available with L36 length. Only available with WH finish. Not compatible with THCLX Hanger or wireguard accessories. LUGR option required for some DLC premium qualifications - Please check the DLC Qualified Products List to determine if LUGR option is necessary to meet requirement. If mounting in continuous rows, ensure all models ordered with LUGR option if required on any configuration to ensure rows match in form factor. LUGR reflectors ship in standard fixture carton and are not sold as separate accessory - this option MUST be specified as part of the CLX model number.
MSD7, MSDPDT7, MSD7ADC, MSDPDT7ADC	Not available with any other control option. Requires EZ1. Sensor housing will be the same color as lens end caps.
N100, N100EMG	nLight EMG option requires a connection to existing nLight network. Power is provided from separate N100 enabled fixture.
ND, WD, AD2	Not available with CLXRN accessories. Available L/LENS only.
NES7, NESPDT7, NES7ADCX, NESPDT7ADCX	Not available with any other control option. Requires EZ1. Requires N100 or N100EMG option, N100EMG with NES7 requires RFA. Sensor housing will be the same color as lens end caps.
NLTAIR2 RES7(EM), NLTAIR2 RES7PDT(EM), NLTAIR2 RIO(EM)	Sensor housing will be the same color as lens end caps. For EM, see UL924 Sequence of Operation chart below.
OCS	Must specify voltage.
OUTCR	Not available with L24. Not available with PLR options.
OUTEND	Not available with PLR options.
PLR1LVG	Not available with Individual controls, NLight Wired, or NLight Wireless options. Refer to page 9 for more PLR details.
SBLW, SBLMB, SBLGV, SBLSKGY	When ordered with L24 only available with 1500LM or 2000LM in combination with GZ10 driver. Not for use with THCLX, CLXANGBKT or WGCLX accessories. Not available with RDL lens options.
SEF	Not available with EZ1 when ordered with L24 with 5000LM or L36 with 7500LM.
SPD	Required with E10W, BGTD.
THCLX ___, CLXANGBKT ____	Not available with louver or wireguards. THCLX___ not available with LUGR.
Wireguards	Not for use with LUGR option. For L96 fixtures, use qty 2 48" wireguards.

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

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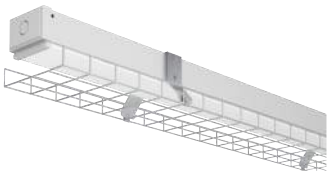
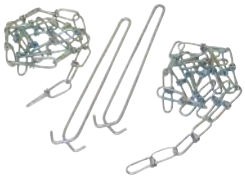
OPTIONS AND ACCESSORIES



Wireguard
Ships separately from fixture:
96" fixture requires two WGCLX48.
Order as:
WGCLX24___
WGCLX36___
WGCLX48___

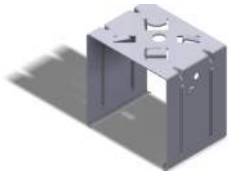
LUGR glare reflector
NOT available as accessory - must be specified as part of the fixture nomenclature. See ordering notes on page 3.

Aircraft Cable with Canopy
Available in 120" or 240"
Order as:
ZAC120
ZAC240



HANGER CHAIN
36" chain with Y hanger. ships as a pair
Order as:
HC36

ZACVH HANGER
10' Aircraft cable with Y hanger.
Order as:
ZACVH



Tong hanger
Ships as a pair
Order As:
THCLX___

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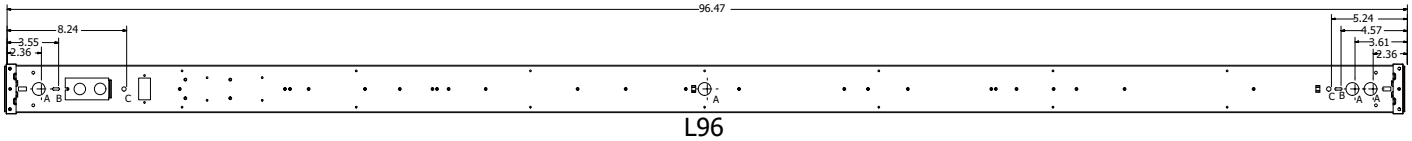
DIMENSIONS

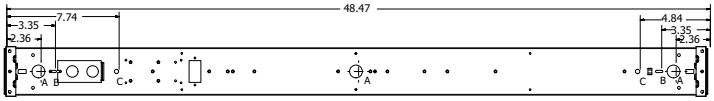
All dimensions are in inches (centimeters) unless otherwise indicated.
Dimensions may vary with options or accessories.

INTEGRATED SENSOR ADDS 2.0 INCHES TO STANDALONE FIXTURE LENGTH
HOUSING END CAP ADDS 0.236 INCHES TO FIXTURE LENGTH PER SIDE. DIMENSIONS BELOW INCLUDE ENDCAPS.

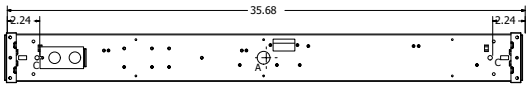
A - 7/8" KNOCK OUT
B - 0.5" by 0.16" SLOT
C - 0.3" DIA HOLE



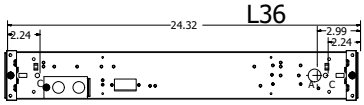
L96



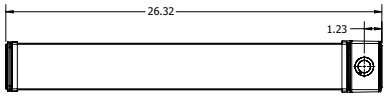
L48



L36



L24

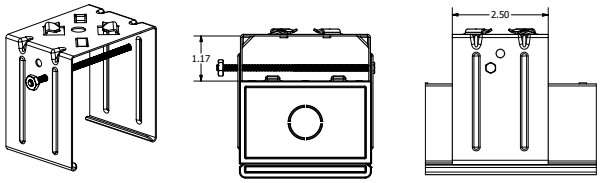


L24 WITH SENSOR

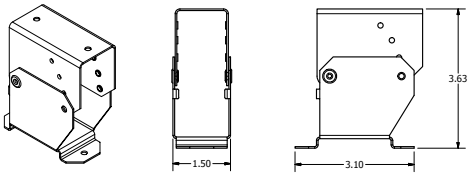
PALLET DIMENSIONS

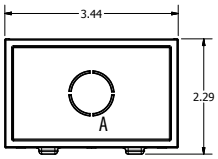
Length	Approx Weight	Fixtures per pallet	Pallet Dims (L X W X H)
L24	4 lb	100	54x46x37
L36	5 lb	80	54x46x37
L48	7.5 lb	64	54x46x37
L96	14 lb	64	98x46x37

THCLX - SHIPS TWO PER ORDER,
UTILIZES A #8 HEX HEAD SCREW AND NUT
FIXTURE SITS 1.3 INCHES FROM STRUCTURE WHEN MOUNTED

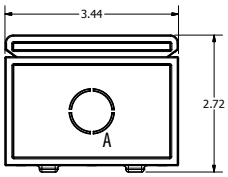


CLXANGBKT - SHIPS TWO PER ORDER
HOLES TO MOUNTING STRUCTURE ARE 0.175" DIA, 2.5" APART
FIXTURE SITS APPROXIMATELY 3.5" FROM STRUCTURE
WHEN MOUNTED HORIZONTAL TO STRUCTURE

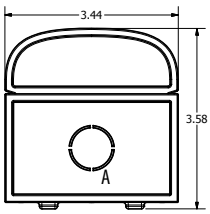




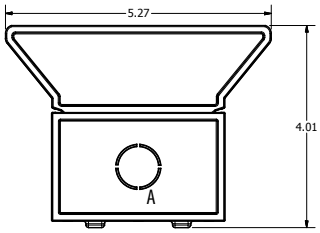
L/LENS



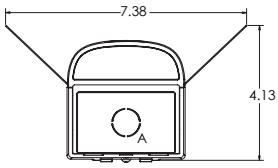
FDL



RDL



WDL



LUGR Reflector Option
- applies to all lens types

PHOTOMETRICS

See www.lithonia.com.

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POWER SENTRY EMERGENCY BATTERY PACKS

		SEF Emergency Lumens	HEF Emergency Lumens
E10W	Factory installable	1400	1500
PS1555LCP	Field installable, remote mount only	2000	2100

Note: For emergency lumen output of specific model, please consult factory. One board will be illuminated during emergency operation.

Emergency Battery Pack Options - Field Installable

Battery Model Number	Wattage	Runtime (Minutes)	Lumen Output* @ 120 Lumens/Watt	Other
ILB CP07 2H A	7W	120	840	Storm Shelter / 2 Hour Runtime
ILB CP10 A	10W	90	1200	
ILBLP CP10 HE SD A	10W	90	1200	Title 20, Self Diagnostic
ILB CP10 HE AELR A	10W	90	1200	Title 20; Enabled with Self Testing, Automated Reporting (STAR)
ILBLP CP15 HE SD A	15W	90	1800	Title 20, Self Diagnostic
ILB CP20 HE A	20W	90	2400	Title 20
ILB CP20 HE SD A	20W	90	2400	Title 20, Self Diagnostic

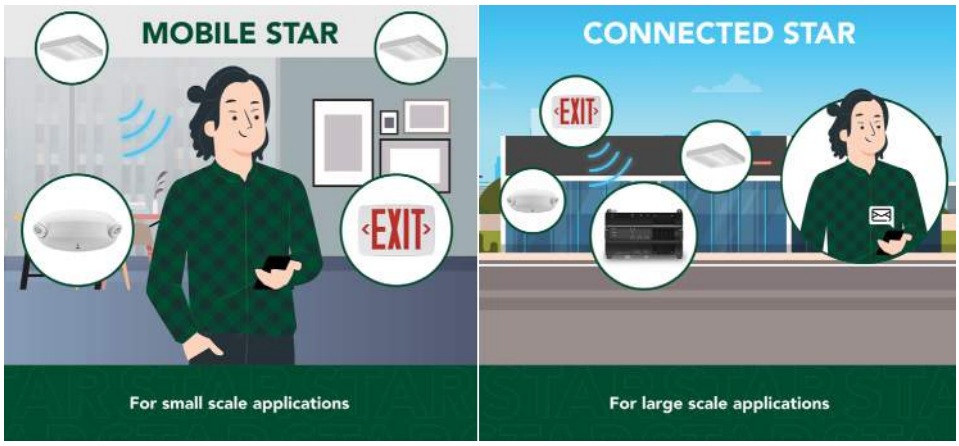
All the above are UL Listed products that are certified for field install external/remote to the fixture.
*Minimum delivered lumen output to assist in product selection for increased fixture mounting height.
The CP10 delivered emergency illumination outperforms legacy 1400 lumen fluorescent emergency ballast.
Please contact us at techsupport@iotaengineering.com for any Emergency Battery related questions.

Enabled with STAR

Emergency Lighting with Self-Testing Automated Reporting (STAR), enables self-testing and automated reporting to aid in life safety code compliance. Build your solution and choose your preferred deployment from Mobile STAR, where test data is logged in each individual unit and broadcast to the CI**AIR**ity™**+** app, or Connected STAR, where test data is logged in the STAR Gateway by IOTA® and emailed directly. **Leave the ladders, disruptions and written records behind with emergency lighting solutions with STAR!**

Life Safety Code NFPA 101 testing and reporting requirements for emergency lighting include:

- Testing for 30 seconds every 30 days
- Testing for 90 minutes once a year
- Record keeping and to report to the authority having local jurisdiction



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CLX CHARACTERISTICS

Nominal Lumen Package	Length	Wattage								Length	Width	Depth	Comparable Light Source
		Standard Efficiency				High Efficiency							
		120V	277V	347V	480V	120V	277V	347V	480V	Dimensions are shown in inches			
2500LM	24"	18.4	18.4	24.0	24.0	17.4	17.4	23.1	23.1	24	3.5	3.75	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
5000LM	24"	41.5	41.5	47.4	47.4	38.1	38.1	44.1	44.1	24	3.5	3.75	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
3750LM	36"	26.5	26.5	32.1	32.1	25.1	25.1	30.7	30.7	36	3.5	3.75	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
7500LM	36"	62.6	62.6	68.6	68.6	54.0	54.0	59.7	59.7	36	3.5	3.75	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
5000LM	48"	31.8	31.8	37.2	37.2	30.3	30.3	35.8	35.8	48	3.5	3.75	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
10000LM	48"	70.7	70.7	76.2	76.2	65.3	65.3	70.8	70.8	48	3.5	3.75	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
10000LM	96"	63.7	63.7	69.0	69.0	60.6	60.6	66.1	66.1	96	3.5	3.75	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
20000LM	96"	141.3	141.3	146.8	146.8	130.5	130.5	136.1	136.1	96	3.5	3.75	6-lamp 32W T8, 4-lamp 54W T5HO, 200W HID

Note: For wattage by configuration, please reference the CLX Operational Data Document.

Lumen Package	UGR Values of CLX L24 @ 80CRI and 3500K UGR (70% 50% 20% reflectance using a 4H x 8H room size)													
	FDL		RDL		WDL		FDL LUGR		RDL LUGR		WDL LUGR		L/LENS	
	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise
1500LM SEF	21.2	23.8	19.4	25.2	17.4	21.1	16.8	14	17.8	16.6	18.1	17.9	24.9	25.1
2000LM SEF	22.3	24.9	20.5	26.3	18.6	22.3	17.9	15.1	18.8	17.6	19.2	18.9	26.1	26.2
2500LM SEF	23.1	25.7	21.3	27.1	19.4	23.1	18.6	15.8	19.6	18.4	19.9	19.7	26.9	27
3500LM SEF	24.1	26.7	22.3	28.1	20.4	24.1	19.7	16.9	20.7	19.5	21	20.8	27.9	28.1
4500LM SEF	25.4	28	23.6	29.4	21.7	25.4	20.7	17.9	21.7	20.5	22	21.8	29.2	29.3
5000LM SEF	25.6	28.2	23.3	29.1	21.4	25.1	21	18.3	21.5	20.3	21.8	21.5	29.4	29.5
1500LM HEF	21.1	23.7	19.3	25.1	21.8	25.5	16.5	13.7	17.6	16.3	17.8	17.6	24.9	25
2000LM HEF	22.2	24.8	20.4	26.2	17.4	21.1	17.6	14.8	18.6	17.4	18.8	18.6	26	26.2
2500LM HEF	23	25.7	21.3	27	18.5	22.2	18.4	15.6	19.4	18.2	19.7	19.4	26.8	27
3500LM HEF	24.1	26.7	22.3	28.1	19.3	23	19.8	17	20.9	19.7	21.1	20.9	27.9	28
4500LM HEF	25.3	27.9	23.5	29.3	20.4	24.1	20.8	18	21.8	20.6	22.1	21.8	29.1	29.3
5000LM HEF	25.5	28.1	23.7	29.5	21.6	25.3	21.1	18.3	22.1	20.9	22.3	22.1	29.3	29.5

UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application

Lumen Package	UGR Values of CLX L36 @ 80CRI and 3500K UGR (70% 50% 20% reflectance using a 4H x 8H room size)							
	FDL		RDL		WDL		L/LENS	
	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise
2250LM SEF	21.4	24.1	19.7	25.6	17.7	21.6	25.2	25.4
3000LM SEF	22.3	25	20.6	26.5	18.6	22.5	26.2	26.3
3750LM SEF	23.2	25.9	21.4	27.3	19.5	23.4	27	27.2
5250LM SEF	24.2	26.9	22.5	28.4	20.5	24.4	28	28.2
6750LM SEF	25.1	27.8	23.3	29.2	21.4	25.3	28.9	29
7500LM SEF	25.4	28.1	23.6	29.5	21.7	25.6	29.2	29.4
2250LM HEF	25	27.7	20.5	26.4	18.6	22.5	25.2	25.3
3000LM HEF	25.3	28	21.4	27.3	19.4	23.3	26.1	26.2
3750LM HEF	21.4	24.1	22.4	28.3	20.5	24.4	27	27.1
5250LM HEF	22.3	25	23.2	29.2	21.3	25.2	28	28.1
6750LM HEF	23.1	25.8	23.6	29.5	21.6	25.5	28.8	29
7500LM HEF	24.2	26.8	19.6	25.5	17.7	21.6	29.1	29.3

UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR and/or "Point-UGR" values.
To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application

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Lumen Package	UGR Values of CLX L48 @ 80CRI and 3500K UGR (70% 50% 20% reflectance using a 4H x 8H room size)													
	FDL		RDL		WDL		FDL LUGR		RDL LUGR		WDL LUGR		L/LENS	
	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise
3000LM SEF	21.8	24.5	19.7	25.3	18.6	23.4	19.2	16.5	20.2	19	20.6	20.3	24.8	25.6
4000LM SEF	22.8	25.5	20.7	26.3	19.6	24.4	20.3	17.5	21.2	20	21.6	21.4	25.8	26.6
5000LM SEF	23.6	26.3	21.4	27	20.4	25.2	21	18.2	21.9	20.7	22.3	22.1	26.6	27.3
7000LM SEF	24.8	27.6	22.7	28.3	21.6	26.5	22.3	19.6	23.3	22.1	23.7	23.4	27.8	28.6
9000LM SEF	25.6	28.4	23.5	29.1	22.5	27.3	23.2	20.4	24.1	22.9	24.5	24.3	28.6	29.4
10000LM SEF	26	28.7	23.8	29.5	22.8	27.6	23.6	20.8	24.5	23.3	24.9	24.7	29	29.8
3000LM HEF	x	x	x	x	x	x	x	x	x	x	x	x	x	x
4000LM HEF	22.8	25.6	20.7	26.3	22.8	25.6	20.3	17.5	21.3	20.1	21.7	21.4	29.5	30.3
5000LM HEF	23.6	26.3	21.4	27	23.6	26.3	21	18.2	21.9	20.7	22.3	22.1	30.2	31
7000LM HEF	24.8	27.6	22.7	28.3	24.8	27.6	22.4	19.6	23.4	22.2	23.8	23.5	27.8	28.6
9000LM HEF	25.7	28.4	23.6	29.2	25.7	28.4	23.2	20.4	24.2	23	24.6	24.3	28.7	29.5
10000LM HEF	26	28.7	23.9	29.5	26	28.7	23.6	20.9	24.6	23.4	25	24.7	29	29.8

UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application

Lumen Package	UGR Values of CLX L96 @ 80CRI and 3500K UGR (70% 50% 20% reflectance using a 4H x 8H room size)													
	FDL		RDL		WDL		FDL LUGR		RDL LUGR		WDL LUGR		L/LENS	
	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise
6000LM SEF	21.8	24.6	19.7	25.4	17.9	22.4	19.3	16.5	20.2	19	20.6	20.4	24.8	25.6
8000LM SEF	22.8	25.5	20.7	26.4	18.8	23.4	20.3	17.6	21.2	20.1	21.6	21.4	25.8	26.6
10000LM SEF	23.6	26.3	21.4	27.2	19.6	24.2	21	18.3	21.9	20.8	22.3	22.1	26.5	27.3
14000LM SEF	24.8	27.6	22.7	28.5	20.9	25.5	22.4	19.6	23.3	22.1	23.7	23.5	27.8	28.6
18000LM SEF	25.7	28.4	23.5	29.3	21.7	26.3	23.2	20.5	24.1	23	24.5	24.3	28.6	29.4
20000LM SEF	26	28.7	23.9	29.6	22	26.6	23.6	20.9	24.5	23.4	24.9	24.7	29	29.7
6000LM HEF	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8000LM HEF	22.8	25.6	20.7	26.5	18.9	23.5	20.4	17.6	21.3	20.1	21.7	21.5	25.8	26.6
10000LM HEF	23.6	26.3	21.4	27.2	19.6	24.2	21	18.3	21.9	20.8	22.3	22.1	27	27.8
14000LM HEF	24.9	27.6	22.7	28.5	20.9	25.5	22.4	19.7	23.4	22.2	23.8	23.5	27.8	28.6
18000LM HEF	25.7	28.4	23.6	29.3	21.7	26.3	23.2	20.5	24.2	23	24.6	24.3	28.7	29.5
20000LM HEF	26	28.8	23.9	29.6	22.1	26.6	23.7	20.9	24.6	23.4	25	24.8	29	29.8

UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application

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AMBIENT TEMPERATURE RATINGS

Driver Package		GZ10			EZ1 or EOHN			Any Driver	
Length	Lumen package	Direct Surface	THCLX/ Suspended	HA Option (Direct or Suspended)	Direct Surface	THCLX	Suspended 18"	Xpoint/ BGTD Direct Surface	E10W Suspended
L24	1500LM	40C	40C	N/A	35C	35C	35C	N/A	N/A
	2000LM	40C	40C		35C	35C	35C		
	2500LM	40C	40C		35C	35C	35C		
	3000LM	40C	40C		40C	40C	40C		
	4500LM	40C	40C		35C	35C	40C		
	5000LM	40C	40C		25C	30C	35C		
L36	2250LM	40C	40C		40C	40C	40C		
	3000LM	40C	40C		40C	40C	40C		
	3750LM	40C	40C		40C	40C	40C		
	5250LM	40C	40C		35C	35C	40C		
	6750LM	30C	40C		35C	35C	40C		
	7500LM	30C	40C		25C	30C	35C		
L48	3000LM	40C	40C	50C	40C	40C	40C	35C	25C
	4000LM	40C	40C	50C	40C	40C	40C		
	5000LM	40C	40C	50C	35C	35C	40C		
	7000LM	30C	40C	N/A	35C	35C	40C		
	9000LM	30C	40C		25C	30C	35C		
	10000LM	30C	40C		25C	30C	35C		
L96	6000LM	40C	40C	50C	35C	35C	40C		
	8000LM	30C	40C	50C	35C	35C	40C		
	10000LM	30C	40C	50C	25C	30C	35C		
	14000LM	40C	40C	N/A	35C	35C	40C		
	18000LM	30C	40C		25C	30C	35C		
	20000LM	30C	40C		25C	30C	35C		

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RRL - RELOC®-Ready Luminaire

- RRL connectors can be used with Quick-Flex®, System 820 and OnePass® systems.
- Load side of connector factory installed to luminaire.
- 4-pole mating connector with push-in terminations allows for simple installation.
- Touch-safe design on both halves meets UL/CSA requirement.
- Wiping contact design allows safe disconnect under load.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: RRLA

Series		Wiring instructions	
RRL	RELOC®-ready luminaire	A	Hot conductor wired to position #1 (phase A)
		B	Hot conductor wired to position #2 (phase B)
		C	Hot conductor wired to position #3 (phase C) [1]

Compatible RELOC® Cables for Industrial Luminaires (ordered and shipped separately)

OCS

OCU

OD

DC

PT

Notes

1 C, ABE, and C12S options are not used with Quick-Flex QFC, QSFC, QPT, and QD.

PLUG-IN WIRING INFORMATION

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Not for use with dedicated emergency circuits.

Note: Specifications subject to change without notice.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires		Branch circuits (PLR2A / PLR2B Only)				Dimming		Ground	
PLR22	(blank)	Not required for PLR22	(blank)	Not required for PLR22			(blank)	No Dimming	G	Ground (required)
PLR	1	Black	(blank)	Not required for PLR1			(blank)	No Dimming	G	Ground (required)
	2	Black and red	**Circuits to which driver is connected**		**Battery charging circuit (must be unswitched)**		LV	Low-voltage Dimming	G	Ground (required)
			(blank)	Not required for PLR22	(blank)	No battery charging circuit				
			A	Black wire	ELA	Battery pack wired to black wire				
			B	Red wire	ELB	Battery pack wired to red wire				

Typical Applications

Notes:

When specifying PLR1, you will not specify A or B as there is only a single hot wire which would be black in color.

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits and 2-circuit PLR22
- Multiple circuit with night-lights located along row as desired

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LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — The GTL LED recessed troffer offers a wide range of lumen packages, color temperatures, and lens options to meet the lighting needs for a wide range of applications such as schools, offices, and hospitals. The light engine delivers long life and excellent color to ensure a sound quality, low-maintenance lighting installation. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate. Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.**

CONSTRUCTION — Housing formed from 22 gauge cold-rolled steel. Smooth hemmed sides and smooth inward formed end flanges for safe handling. Includes integral T-bar clips. Lighter-weight fixture allows for safe, easy installation.

OPTICS — Highly transmissive pattern #12 lens diffuses the light source without compromising output. Pattern # 19 and satin white lens options also available.

ELECTRICAL — Long-life LEDs, coupled with high-efficiency drivers, provide extended service life. 80% LED lumen maintenance at 72,000 hours (L80/72,000).

eldoLED driver options deliver choice of dimming range, and choices for control, while assuring flicker-free, low-current inrush, 89% efficiency and low EMI.

Optional nLight® embedded controls make each luminaire addressable - allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices and the GTL luminaires using standard Cat-5 cabling. Unique plug-and-play convenience as devices and luminaires automatically discover each other and self-commission.

Lumen Management: Unique lumen management system (option N80) provides onboard intelligence that actively manages the LED light source so that constant lumen output is maintained over the system life, preventing the energy waste created by the traditional practice of over-lighting.

The step-level dimming option (SLD) allows the system to be switched to 50% power for compliance with common energy codes while maintaining fixture appearance.

Ballast disconnect is provided where required to comply with U.S. and Canadian codes.

INSTALLATION — LED boards include plug-in connectors for easy of upgradeability. Suitable for direct insulation contact. Suitable for damp location.

LISTINGS — CSA certified to meet U.S. and Canadian standards. IC rated. DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

GOVERNMENT PROCUREMENT — BAA – Product with the BAA option qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product with the BAA option also qualifies as manufactured in the United States under DOT Buy America regulations.
BABA – Build America Buy America: Product with the BAA option also qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

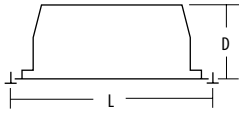
Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

GTL Series

GTL

1' x 4'
LED Recessed Troffer

Specifications	
Length:	47.75 (121.3)
Width:	11.75 (29.8)
Depth:	4.5 (11.4)



All dimensions are inches (centimeters) unless otherwise indicated.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

GTL LED Troffer

A+ Capable options indicated by this color background.

ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

Example: GTL 4 40L GZ10 LP835

GTL

Series	Trim type	Length	Lumens[1]	Door	Lens	Voltage
GTL 1' wide recessed LED luminaire	(blank) Grid F Overlapping flange	4 4'	20L 2000 lumens 33L 3300 lumens 40L 4000 lumens 48L 4800 lumens	(blank) Flush steel, white FN Flush aluminum, natural FM Flush aluminum, matte black FW Flush aluminum, white RN Regressed aluminum, natural RM Regressed aluminum, matte black RW Regressed aluminum, white	(blank) #12 pattern acrylic, 0.110" thick A12125 #12 pattern acrylic, frosted, .125" thick A19 #19 pattern acrylic, 0.156" thick SWL Satin white	(blank) MVOLT (120-277V) 120 120V 277 277V 347 347V[2]

Driver	Color temperature	Controls[4,5]	Options
EZ1 eldoLED dims to 1% (0-10V dimming) GZ10 Dims to 10% (0-10V dimming) GZ1 Dims to 1% (0-10V dimming) SLD Step-level dimming[3]	LP830 3000 K LP835 3500 K LP840 4000 K LP850 5000 K	(blank) No controls N80 nLight with 80% (L80) lumen management N80EMG nLight with 80% (L80) lumen management for use with generator supply emergency power N100 nLight without lumen management N100EMG nLight without lumen management for use with generator supply emergency power	BDP Disconnect Plug E7W 7W Emergency battery pack, constant power, Certified in CA Title 20 MAEDBS, User selectable Self-Diagnostic, AC Activate with Integral Test Switch (LINK)[3,6,7] E10W Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS, CA Title 20 MAEDBS, User selectable Self-Diagnostic, AC Activate with Integral Test Switch (LINK)[3] BGTD Bodine Generator Transfer Device[8,9] CP Chicago plenum[10] PWS1836 6' pre-wire, 3/8" diameter, 18-gauge, 1-circuit PWS1846 6' pre-wire, 3/8" diameter, 18-gauge, 2-circuit ABC Door frame gasketing[11] GLR Fast-blowing fuse[12] GMF Slow-blowing fuse[12] LATC Earthquake clip NPLT Narrow pallet PAF Paint after fab BAA Buy America(n) Act and/or Build America Buy America Qualified

Accessories: *Order as separate catalog number.*

DGA14	Drywall grid adapter for 1x4 recessed fixture.
RK8BDP 2P U	Disconnect Plug (BDP), 2 Pole, Package of 1
RK8BDP 3P U	Disconnect Plug (BDP), 3 Pole, Package of 1
RK8BDP 2P J10	Disconnect Plug (BDP), 2 Pole, Package of 10
RK8BDP 2P J40	Disconnect Plug (BDP), 2 Pole, Package of 40

Notes

1. Approximate lumen output. Lumen output will vary depending upon lens option chosen.
2. Not available with SLD, E7W, E10W, or BGTD.
3. When using pre-wire option, use PWS1846.
4. Not available with SLD, GZ10, GZ1.
5. Cannot row mount when ordered with nLight options.
6. Not available with EZ1, and SLD when combined with 40L or 48L lumen packages.
7. Not available with GZ1 or GZ10 when combined with 48L lumen package.
8. Not available with SLD. When using a pre-wire option, use PWS1846 or PWS1846 PWSLV.
9. Must specify voltage. Requires BSE labeling, voltage specific.
10. Not available with PWS1836, PWS1846, PWS1856LV, or PWS1846 PWSLV.
11. Only available with aluminum door.
12. Must specify voltage, 120 or 277.

Stock/Non-configurable models are offered for shorter lead times:

ORDERING INFORMATION

Catalog Number	UPC	Description	Lumens	Color Temprature	Voltage	Wattage	Pallet qty.	Standard carton qty.
GTL4 3700LM LP835	889804707076	1x4 LED lay-in troffer	3696	3500K	120-277V	30.94W	40	1
GTL4 3700LM LP840	889804707090	1x4 LED lay-in troffer	3844	4000K	120-277V	30.94W	40	1
GTL4 3700LM 347 LP835	889804707212	1x4 LED lay-in troffer, 347v	3696	3500K	347V	35.34W	40	1
GTL4 3700LM 347 LP840	889804707335	1x4 LED lay-in troffer, 347v	3844	4000K	347V	35.34W	40	1
GTL4 3700LM E10W LP835	889804707441	1x4 LED lay-in troffer, emergency battery	3696	3500K	120-277V	30.94W	40	1
GTL4 3700LM E10W LP840	889804707724	1x4 LED lay-in troffer, emergency battery	3844	4000K	120-277V	30.94W	40	1

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Emergency Battery Pack Options – Field Installable

Battery Model Number	Wattage	Runtime (Minutes)	Lumen Output* @ 120 Lumens/Watt	Other
ILB CP07 2H A	7W	120	840	Storm Shelter / 2 Hour Runtime
ILB CP10 HE AELR A	10W	90	1200	Title 20, STAR Enabled Wireless reporting
ILB CP10 A	10W	90	1200	
ILBLP CP10 HE SD A	10W	90	1200	Title 20, Self Diagnostic
ILBLP CP15 HE SD A	15W	90	1800	Title 20, Self Diagnostic
ILB CP20 HE AELR HV A	20W	90	2400	Title 20, STAR Enabled Wireless reporting
ILB CP20 HE A	20W	90	2400	Title 20
ILB CP20 HE SD A	20W	90	2400	Title 20, Self Diagnostic

All the above are UL Listed products that are certified for field install external/remote to the fixture.
*Minimum delivered lumen output to assist in product selection for increased fixture mounting height.
The CP10 delivered emergency illumination outperforms legacy 1400 lumen fluorescent emergency ballast.
Please contact us at techsupport@iotaengineering.com for any Emergency Battery related questions.

BSE Labeling Options	
BSE10	Drivers load transfer relay installed per manufacturer's instructions. Voltage, BGTD and BSE10 called out.
BSE14	One voltage fixture with driver load control relay supplied with one prewire (PWS option). Prewire wired for normal circuit, the control relay for emergency circuit left unconnected. Voltage, BGTD, BSE14 and prewire called out, in the description.

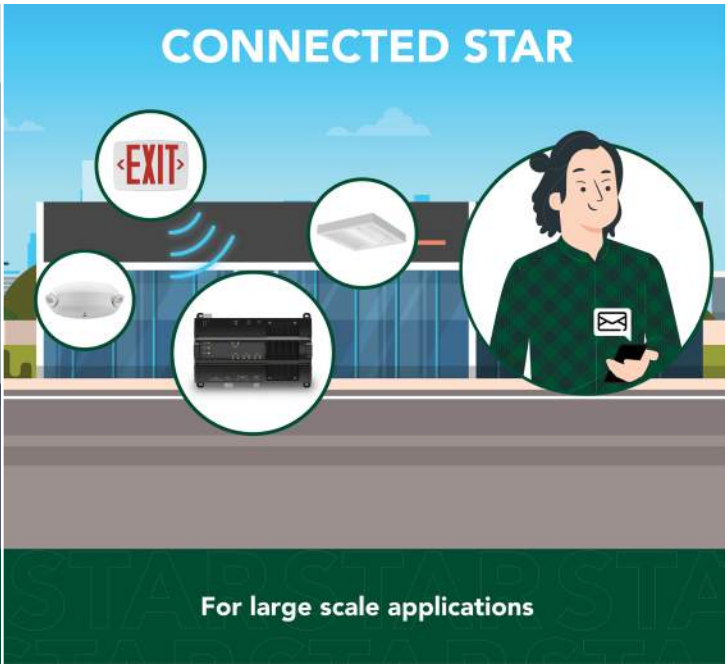
*For configurations with Reloc or two voltages an RFA modification is required.

Enabled with STAR

Emergency Lighting with Self-Testing Automated Reporting (STAR), enables self-testing and automated reporting to aid in life safety code compliance. Build your solution and choose your preferred deployment from Mobile STAR, where test data is logged in each individual unit and broadcast to the Cl**AIR**ity™**+** app, or Connected STAR, where test data is logged in the STAR Gateway by IOTA® and emailed directly. **Leave the ladders, disruptions and written records behind with emergency lighting solutions with STAR!**

Life Safety Code NFPA 101 testing and reporting requirements for emergency lighting include:

- Testing for 30 seconds every 30 days
- Testing for 90 minutes once a year
- Record keeping and to report to the authority having local jurisdiction



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Performance Data			
Lumen Package	**Lumens**	**Input Watts**	**LPW**
20L LP830	2286.34	18.46	124
20L LP835	2333	18.46	126
20L LP840	2426.32	18.46	131
20L LP850	2472.98	18.46	134
33L LP830	3265.36	28.4	115
33L LP835	3332	28.4	117
33L LP840	3465.28	28.4	122
33L LP850	3531.92	28.4	124
40L LP830	3798.48	34.1	111
40L LP835	3876	34.1	114
40L LP840	4031.04	34.1	118
40L LP850	4108.56	34.1	120
48L LP830	4824.54	42.33	114
48L LP835	4923	42.33	116
48L LP840	5119.92	42.33	121
48L LP850	5218.38	42.33	123

Note: Performance based on standard #12 pattern acrylic lens.

How to Estimate Delivered Lumens in Emergency Mode

Use the formula below to estimate the delivered lumens in emergency mode

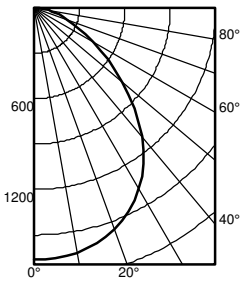
Delivered Lumens = 1.25 x P x LPW

P = Ouput power of emergency driver. P = 10W for E10WLCP option.

LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet. LPW = Lumen per watt rating of the luminaire. LPW information available in Performance Data section.

PHOTOMETRICS

GTL 4 40L LP835, 3914 delivered lumens, test no. ISF 36856P10, tested in accordance to IESNA LM-79.



	Ave	Lumens
0	1665	
5	1660	158
15	1610	454
25	1482	681
35	1258	783
45	935	719
55	594	533
65	331	332
75	173	185
85	64	69
90	0	

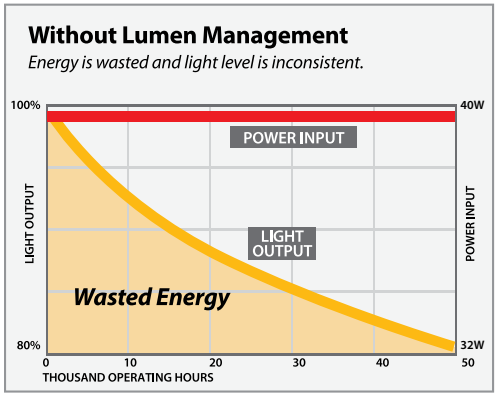
Zone	Lumens	% Lamp
0° - 30°	1292.9	33.0
0° - 40°	2075.9	53.0
0° - 60°	3328.9	85.0
0° - 90°	3914.3	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	3914.3	*100.0
*Efficiency		

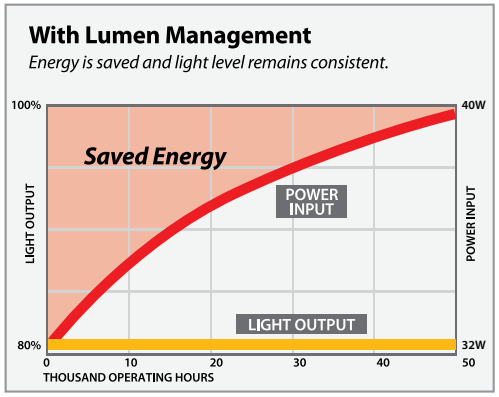
pf	80%			20%			70%			50%		
pc	50%	30%	10%	50%	30%	10%	50%	30%	10%	50%	30%	10%
pw												
0	119	119	119	116	116	116	111	111	111			
1	105	101	98	103	100	96	99	96	93			
2	93	87	82	91	85	81	88	83	79			
3	83	75	69	81	74	69	78	72	67			
4	74	66	60	73	65	59	70	64	58			
5	67	58	52	66	58	52	64	57	51			
6	60	52	46	60	52	46	58	51	45			
7	55	47	41	54	46	41	53	46	41			
8	51	42	37	50	42	37	49	41	36			
9	47	39	33	46	38	33	45	38	33			
10	43	35	30	43	35	30	42	35	30			

		50% beam - 63.6°		10% beam - 104.1°	
Mounting Height	Inital FC Center Beam	Diameter	FC	Diameter	FC
8.0	51.4	6.8	25.7	14.1	5.1
10.0	28.6	9.3	14.2	19.2	2.8
12.0	18.1	11.8	9.0	24.4	1.8
14.0	12.4	14.3	6.2	29.5	1.2
16.0	9.1	16.7	4.5	34.6	0.9

Constant Lumen Management

Enabled by the embedded nLight control, the GTL actively tracks its run-time and manages its light source such that constant lumen output is maintained over the system life. Referred to as lumen management, this feature eliminates the energy waste created by the traditional practice of over-lighting.





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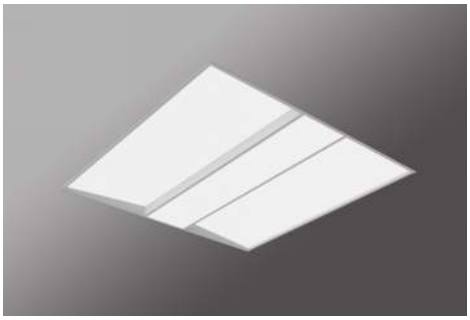
PINNACLE ARCHITECTURAL LIGHTING®

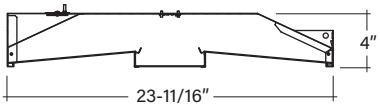
Project Name _____

Date _____ Type _____



TRAVERSE TR22

2x2 Architectural Recessed



Key Features

- Three-piece luminous lens design offers elevated style and visual comfort
- White or Silver center rails
- Up to 6000 delivered lumens (2x2) with 80CRI or 90CRI options
- High performance efficacy up to 147 lumens per watt
- Lift and shift lenses allow for easy room-side maintenance
- Multiple integrated control options for enhanced energy savings
- 5-year limited warranty

Example Part #: TR22-W-830HO-G1-U-FSD-1-0-W

TR22 - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____

SHIELDING | *CRI, CCT & OUTPUT* | *MOUNTING* | *VOLTAGE* | *DRIVER* | *CIRCUITING* | *BATTERY & EMERGENCY* | *FINISH* | *FIXTURE OPTIONS* | *CONTROLS*

SHIELDING (– –)

W - Satine Lens with White Rails QS
S - Satine Lens with Silver Rails
Shielding pg. 2

SOURCE[1] QS (– – – – – –)

_27_ _ - 2700K
_30_ _ - 3000K
_35_ _ - 3500K
_40_ _ - 4000K
CL_ _ _ _ _ _ - Custom Lumens
CW_ _ _ _ _ _ - Custom Watts
Lumen Output pg. 2

MOUNTING (– – – – – –)

G1 - 15/16" Grid QS
G9 - 9/16" Grid QS
GS - Screw Slot Grid QS
FL - Flanged
Mounting pg. 3

VOLTAGE (–)

U - Universal *(120 thru 277V)* QS
1 - 120V QS
2 - 277V QS
3 - 347V
Voltage pg. 3

DRIVER (– – –)

FSD - Factory Select Driver *(1%, 0-10v)* QS
PL2 - Advance Xitanium *(1%, 0-10v)* QS
OL2 - eldoLED Optotronic *(1%, 0-10v)* QS
OL2 - eldoLED Optotronic 347v *(1%, 0-10v)*
OL5 - eldoLED Optotronic *(1%, 0-10v)*
EE1 - eldoLED ECOdrive *(1%, 0-10v)*
EE2 - eldoLED ECOdrive *(1%, 0-10v)*
LH1 - Lutron Hi-lume *(1%, EcoSystem)*
PR1 - Advance Xitanium SR
Driver pg. 4

CIRCUITING (–)

1 - Single Circuit QS
E - Emergency QS
(entire fixture)
N - Night Light QS
(entire fixture)
Circuiting pg. 4

BATTERY & EMERGENCY (– – –)

0 - None QS
FSB - Factory Select Battery QS
FSG - Factory Select ALCR
GI - Iota ETS DR
GB - Bodine GTD
1ILL - Iota 10W, Lithium, Self Testing QS
1PLL - Bodine 10W, Lithium, Self Testing QS
Battery and Emergency pg. 4

FINISH (– –)

W - White QS
Finish pg. 5

FIXTURE OPTIONS[2] (– – – –)

QS - QuickShip QS
TW - Through-wiring
CP - Chicago Plenum QS
AR - Air Return
AM - Antimicrobial Paint
FW6 - 6' Flex Whip QS
Fixture Options pg. 5

CONTROLS[3] (– – –)

DLMFC - Wattstopper DLM *(wired)*
DLMFS - Wattstopper LLLC *(wireless)*
SNSLM - Encelium SensiLUM *(wireless)*
LEVIS0 - Leviton Intellect Sensor *(wireless)*
ENL_ - Enlighted IOT *(wireless)*
ENL2_ - Enlighted 2-Wire IOT *(wireless)*
Controls pg. 6

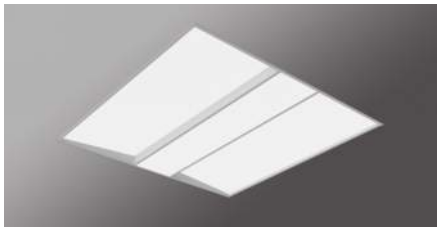
[1]When specifying SOURCE the first _ is for specifying either 8 - 80CRI or 9 - 90CRI. The ending _ _ are for specifying output, example HO - High Output. See output charts for more information. [2]If specifying QS, QS must be used in fixture options section of part number to qualify. [3]Controls can only be used with Single Circuit (1) or Emergency Circuit (E). See Controls chart on page 5 for driver options and more information.

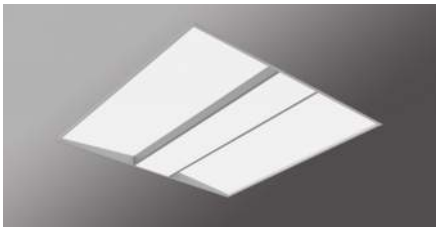
Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

Shielding

- Three piece acrylic diffuse lens
- Fully luminous housing with optimal glare control
- Highly reflective white reflectors maintain uniform lens brightness

W	S
Satine Lens with White Rails	Satine Lens with Silver Rails





Output

- Specify either 80 or 90 CRI
- Longer lead-time may apply for 90 CRI. Consult factory.
- 90 CRI = R9≥50

Custom Output- Lumens OR Wattage

CL_____	Specify CRI, CCT and desired lumens (i.e. CL8351200)	*Specify lumens between standard offering listed below. Lumens are specified per color temp*
CW_____	Specify CRI, CCT and desired wattage (i.e. CW94015)	*Specify watts between standard offering listed below*

80 CRI

	Color	Output	Watts	Shielding			
				W White Trim		**S** Silver Trim	
				Lumens	*LPW*	*Lumens*	*LPW*
830LO	3000K	Low	17.0	2416	142	1981	117
830MO	3000K	Middle	28.5	3820	134	3133	110
830HO	3000K	High	38.2	4995	131	4096	107
830VHO	3000K	Very High	46.1	5875	127	4817	104
835LO	3500K	Low	17.0	2426	143	1989	117
835MO	3500K	Middle	28.5	3836	135	3146	110
835HO	3500K	High	38.2	5016	131	4113	108
835VHO	3500K	Very High	46.1	5899	128	4838	105
840LO	4000K	Low	17.0	2491	147	2043	120
840MO	4000K	Middle	28.5	3939	138	3230	113
840HO	4000K	High	38.2	5151	135	4224	111
840VHO	4000K	Very High	46.1	6058	131	4967	108

90 CRI

927LO	2700K	Low	17.0	2004	118	1643	97
927MO	2700K	Middle	28.5	3168	111	2598	91
927HO	2700K	High	38.2	4143	108	3397	89
927VHO	2700K	Very High	46.1	4872	106	3995	87
930LO	3000K	Low	17.0	2052	121	1683	99
930MO	3000K	Middle	28.5	3245	114	2661	93
930HO	3000K	High	38.2	4243	111	3480	91
930VHO	3000K	Very High	46.1	4990	108	4092	89
935LO	3500K	Low	17.0	2142	126	1756	103
935MO	3500K	Middle	28.5	3387	119	2777	97
935HO	3500K	High	38.2	4428	116	3631	95
935VHO	3500K	Very High	46.1	5208	113	4270	93
940LO	4000K	Low	17.0	2199	129	1803	106
940MO	4000K	Middle	28.5	3477	122	2851	100
940HO	4000K	High	38.2	4546	119	3728	98
940VHO	4000K	Very High	46.1	5346	116	4384	95

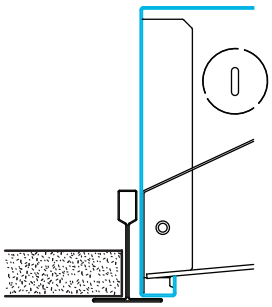
Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

Mounting

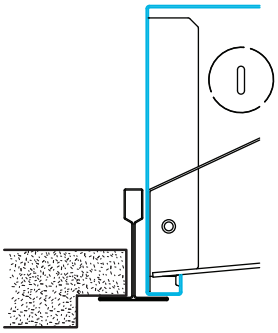
- TRAVERSE can be ordered for all grid types. See below for fixture placement in relation to the tile for each grid type
- Grid retention clips integral to housing and require mechanical attachment
- Tie off fixture to structure with retention wires
- Refer to installation instructions during installation at the jobsite
- Approved for dry/damp location
- Maximum fixture weight is 15.4lbs

G1

1" Grid Mount
Works with 15/16" grid ceiling types. See profile for fixture position in relation to ceiling grid and tile.



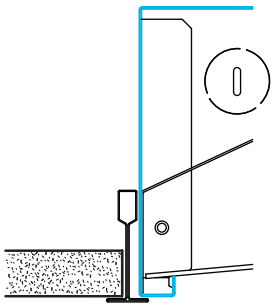
Standard Tile



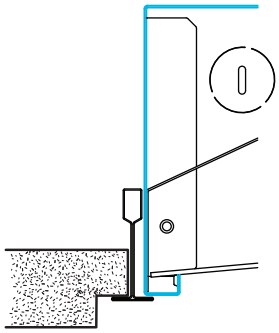
Tegular Tile

G9

9/16" Grid Mount
Works with 9/16" grid ceiling type. For tegular tile installations, fixture position will not be flush to the bottom of the tile. See tegular tile profile image below.



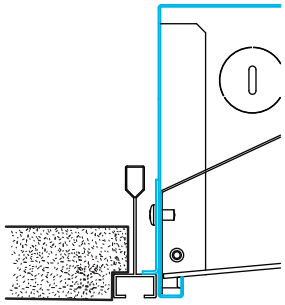
Standard Tile



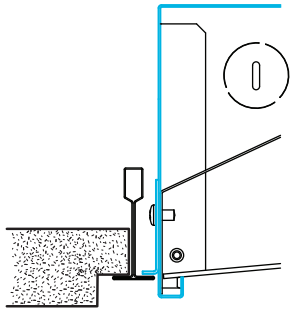
Tegular Tile

GS

Screw Slot Mounting
Works with screw slot and bolt slot grid ceiling types.



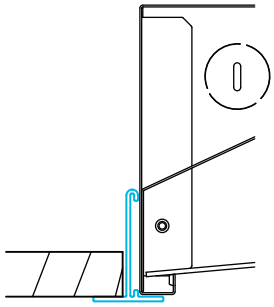
Standard Tile

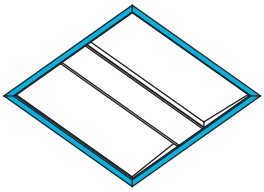


Tegular Tile

FL

Flange Kit
A separate flange kit is supplied for installations into inaccessible or drywall applications. Flange kit ships from factory uninstalled separately from fixture.





Voltage

- Some TRAVERSE configurations will not accommodate all voltage options; consult with factory

U	Universal
1	120 volt
2	277 volt
3	347 volt

Driver

- Standard Driver Option = FSD
- Driver Lifetime: 50,000 hours at 25°C ambient operating conditions
- For more Driver options, see Pinnacle Resource Guide
- Some TRAVERSE configurations will not accommodate all driver options; consult with factory

0-10V Drivers	
FSD	Factory Select Driver 1%, 0-10v
PL2	Advance Xitanium 1%, 0-10v
OL2	eldoLED Optotronic, 1%, 0-10v
OL4	eldoLED Optotronic 347v, 1% 0-10v, requires 347v option
EE1	eldoLED ECOdrive 1%, 0-10v, Logarithmic
EE2	eldoLED ECOdrive 1%, 0-10v, Linear
ES1	eldoLED SOLOdrive 0.1%, 0-10v, Logarithmic
ES2	eldoLED SOLOdrive 0%, 0-10v, Linear
OL5	eldoLED Optotronic 1%, 0-10v, AUX
DALI Drivers	
EE3	eldoLED ECOdrive .1%, DALI, Logarithmic
OD1	eldoLED Optotronic 1%, DEXAL
PR1	Advance Xitanium SR, DALI 2, Self powered link
Lutron Drivers	
LH1	Lutron Hi-lume Soft-on, Fade-to-black 1%, EcoSystem, LDE1

Circuiting

- Select fixture circuiting from options below
- Some TRAVERSE configurations will not accommodate all circuiting options; consult with factory

1	Single Circuit
E	Emergency Circuit only
N	Night Light Circuit only

Battery & Emergency

- Select battery or emergency options if required
- Battery duration is 90 minutes
- Test button is integral to fixture
- For more Battery options, see Pinnacle Resource Guide

0	No Battery
FSB	Factory Select Battery 10w, Integral Lithium
FSG	Factory Select ALCR Emergency Control Device, UNV
GI	Iota ETS-DR, Emergency Control Device, UNV
GB	Bodine GTD, Emergency Control Device, 120v or 277v
1ILL	Iota 10w, Integral Lithium, Self Testing
1PLL	Bodine 10w, Integral Lithium, Self Testing

For Approximate Battery Lumen Output

- Multiply battery wattage X fixture LPW shown on Lumen Table
- 10 (watts) x 92.3 (LPW) = 923 battery lumen output

Battery & Emergency Ordering Examples

- Single circuit, 10w integral battery — Ordering Code: 1-1PLL
- Emergency circuit only, 10w integral battery — Ordering Code: E-1PLL

Finish

- Powder-coat white painted finish

W	White

Fixture Options

- Additional options to enhance the fixture and finish of the product

QS	Quick Ship
TW	Through-Wiring
CP	Chicago Plenum
AM	Antimicrobial Paint
AR	Air Return
FW6	Flex Whip 6′

Quick Ship

Shielding	Output	Mounting	Voltage	Driver	Circuiting	Battery	Finish	Options
10-Day								
W White Rails	80 CRI, All color temperatures, all lumen packages *See pg 2*	**G1** 1″ Grid **G9** 9/16″ Grid **GS** Screw Slot	**U** Universal **1** 120v **2** 277v	**FSD** Factory Select Driver *(1%, 0-10v)* **PL2** Advance Xitanium 0-10v, 1% **OL2** Osram 0-10v, 1%	**1** Single **E** Emergency **N** Night Light	**0** None **FSB** Factory Select Battery **ILL** Iota 10w **PLL** Bodine 10w	**W** White	**CP** Chicago Plenum **FW6** Flex Whip 6′ 18-gauge

Consult Factory for projects that are larger than 200 units.

Controls

- Pinnacle Lighting offers easy to specify network control solutions that connect to an intelligent centralized system to maximize lighting energy efficiencies or integral sensors for individual fixture control
- Pinnacle Lighting fixtures ship technology ready; commissioning by others
- Controls can only be used with Single Circuit (**1**) or Emergency Circuit (**E**)
- Contact factory for any non-standard configurations for layout, placement, or EM options
- Must specify required driver in Driver section

	Solution	Components	Network/Sensor	Connection	Required Drivers	Limitations
DLMFC	Legrand Wattstopper DLM	LMFC-011	Digital Lighting Management (DLM)	Wired, two RJ45 ports	OL2	Not available with Battery
DLMFS	Legrand Wattstopper LLLC	LMFS-601-W / LMFI-111	Wireless DLM Fixture Sensor	Wireless	OD1, PR1I or 0-10v	0-10v requires interface
SNSLM	Encelium SensiLUM	EN-CLM-PIR-DD-ZB	Encelium, Daylight/PIR Occupancy	Wireless	OD1, OL5	
LEVIS0	Leviton Intellect Sensor	ZL07S-N00	Leviton Intellect, Daylight/PIR Occupancy	Wireless	OL5	
ENLI	Enlighted IOT	SU-5E-IOT	Enlighted, Daylight/PIR Occupancy	Wireless	ANY 0-10V	
ENLC	Enlighted Connected Lighting	SU-5E-CL	Enlighted, Daylight/PIR Occupancy	Wireless	ANY 0-10V	
ENL2I	Enlighted 2-Wire IOT	KIT-SU-5E-D-IOT	Enlighted, Daylight/PIR Occupancy	Wireless	OD1, PR1	
ENL2C	Enlighted 2-Wire Connected Lighting	KIT-SU-5E-D-CL	Enlighted, Daylight/PIR Occupancy	Wireless	OD1, PR1	

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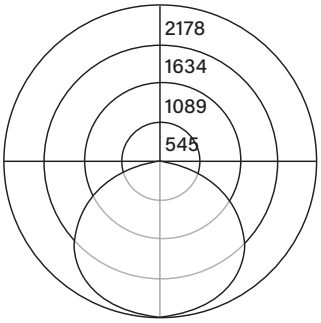
Photometrics

Satine Lens

Test #	5157-5
Catalog #	TR22-W-835
Lumens	6209 lm
Watts	46.7 W
Efficacy	133 LPW



Candela Distribution

Vert Angle	Horizontal Angle 0	22.5	45	67.5	90
0	2172	2172	2172	2172	2172
5	2169	2160	2157	2159	2163
10	2134	2124	2125	2131	2136
15	2077	2069	2076	2088	2097
20	1999	1994	2010	2034	2049
25	1902	1902	1932	1969	1990
30	1789	1793	1838	1893	1923
35	1659	1668	1727	1801	1839
40	1515	1529	1600	1686	1731
45	1362	1378	1457	1548	1595
50	1206	1220	1300	1387	1430
55	1040	1052	1126	1201	1239
60	870	880	940	999	1029
65	700	701	746	790	812
70	532	529	557	584	598
75	366	362	377	392	400
80	215	212	215	220	223
85	142	184	175	165	163
90	20	19	20	20	22

Luminance Data (cd/sq.m)

Angle In Degrees	Average 0-Deg	Average 45-Deg	Average 90-Deg
45	5178	5538	6064
55	4875	5278	5809
65	4453	4746	5163
75	3797	3914	4157
85	4394	5394	5021

For all available IES files, please visit our website at pinnacle-ltg.com. Photometry testing in accordance to IESNA-LM-79-08 at an NVLAP accredited testing laboratory. Testing conducted at 25°C ambient conditions

Approvals & Certifications

Construction: Formed 24 gauge cold rolled steel housing. Highly reflective die-formed reflectors maintain uniform lens brightness. Wiring access on both sides and top of housing. Housing designed to maintain optimal temperature of LED diodes and driver and allow for room-side maintenance of lens, driver and LED boards.

Shielding: 3 piece diffuse lens with center spine creating a fully luminous housing with optimal glare control. Available with white or silver lens side rails.

Mounting: Designed to install into acoustical grid and inaccessible ceilings. Specify G1, G9 or GS for acoustical grid ceiling. Specify FL for inaccessible ceilings. Grid retention clips integral to housing and require mechanical attachment. Tie off fixture to structure with retention wires. Maximum fixture weight is 15.4 lbs.

LED: 25°C test environment. Lumen output/wattage has a margin of +/- 5%. Luminaire configurations tested in accordance with IES LM-79. Diodes tested in accordance with IES LM-80. Lifetime calculated using IES TM-21. Minimum lifetime greater than 60,000 hours. Lifetime Projection L70 = 275,000 hours and L90 = 83,000 hours. MacAdam 3-Step Ellipses. For all available IES files, please visit our website at pinnacle-ltg.com.

Color & Lumen Output: Not all lumen packages available. Four lumen packages available. Low (LO), Medium (MO), High (HO) and Very High (VHO). Custom outputs are available. Specify custom lumens or watts between standard offering listed on CRI, CCT & Output page. 80 CRI is available for 3000K, 3500K, and 4000K. 90 CRI is available for 2700K, 3000K, 3500K and 4000K. 90 CRI = R9≥50.

Voltage: Universal (U), 120 volt (1), 277 volt (2) and 347 volt (3) options available. Some TRAVERSE configurations will not accommodate all voltage options; consult with factory.

Driver: Standard Driver Option is Factory Select Driver 0-10V, 1% = FSD. Electronic driver, Power factor is >0.9 with a THD <20%. Driver Lifetime: 50,000 hours at 25°C ambient operating conditions. Ambient operating range: -20°F/-30°C to 87°F/30C. For more driver options, see Pinnacle Resource Guide. Some TRAVERSE configurations will not accommodate all driver options.

Circuiting: Select from single circuit (1), Emergency circuit (E) or Night Light circuit (N). Some TRAVERSE configurations will not accommodate all circuiting options, consult with factory.

Battery & Emergency: Select battery or emergency options if required. If battery or emergency option is not required, enter 0. Battery duration is 90 minutes as standard. Test button is integral to fixture. For more Battery options, see Pinnacle Resource Guide.

Finish: Powder coat white painted finish.

Controls: DLM utilizes wired network connections for digital control through switching and dimming. ENCELIUM SensiLUM sensor provides wireless control, daylight harvesting and PIR occupancy using 0-10V, DEXAL or SR LED drivers. Leviton Intellect sensor provides wireless control, daylight harvesting and PIR occupancy detection using 0-10V, DEXAL or SR LED drivers. Enlighted Smart Sensor provides multi-functionality including daylight harvesting and PIR occupancy; for IOT or Connected platform using 0-10V, DEXAL or SR LED drivers.

Labels: UL and cUL 1598 listed. LO, MO, HO and VHO lumen packages are IC Rated. Approved for dry/damp location unless otherwise noted.

Fixture Weight: 15.4 lbs maximum.

Warranty: TRAVERSE LED offered with a 5-year limited warranty. Covers LED, driver and fixture.

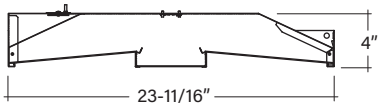
PINNACLE ARCHITECTURAL LIGHTING®

Project Name _____

Date _____ Type _____

TRAVERSE TR24

2x4 Architectural Recessed



Key Features

- Three-piece luminous lens design offers elevated style and visual comfort
- White or Silver center rails
- Up to 8000 delivered lumens (2x4) with 80CRI or 90CRI options
- High performance efficacy up to 154 lumens per watt
- Lift and shift lenses allow for easy room-side maintenance
- Multiple integrated control options for enhanced energy savings
- 5-year limited warranty

Example Part #: TR24-W-830HO-G1-U-FSD-1-0-W

TR24 - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____

SHIELDING	CRI, CCT & OUTPUT	MOUNTING	VOLTAGE	DRIVER	CIRCUITING	BATTERY & EMERGENCY	FINISH	FIXTURE OPTIONS	CONTROLS

SHIELDING (_ _)

W - Satine Lens with White Rails QS
S - Satine Lens with Silver Rails
Shielding pg. 2

SOURCE[1] QS (_ _ _ _ _ _)

_27_ _ - 2700K
_30_ _ - 3000K
_35_ _ - 3500K
_40_ _ - 4000K
CL_ _ _ _ _ _ - Custom Lumens
CW_ _ _ _ _ _ - Custom Watts
Lumen Output pg. 2

MOUNTING (_ _ _ _ _ _)

G1 - 15/16" Grid QS
G9 - 9/16" Grid QS
GS - Screw Slot Grid QS
FL - Flanged
Mounting pg. 3

VOLTAGE (_)

U - Universal *(120 thru 277V)* QS
1 - 120V QS
2 - 277V QS
3 - 347V
Voltage pg. 3

DRIVER (_ _ _)

FSD - Factory Select Driver *(1%, 0-10v)* QS
PL2 - Advance Xitanium *(1%, 0-10v)*
OL2 - eldoLED Optotronic *(1%, 0-10v)*
OL2 - eldoLED Optotronic 347v *(1%, 0-10v)*
OL5 - eldoLED Optotronic *(1%, 0-10v)*
EE1 - eldoLED ECOdrive *(1%, 0-10v)*
EE2 - eldoLED ECOdrive *(1%, 0-10v)*
LH1 - Lutron Hi-lume *(1%, EcoSystem)*
PR1 - Advance Xitanium SR
Driver pg. 4

CIRCUITING (_)

1 - Single Circuit QS
E - Emergency QS
(entire fixture)
N - Night Light QS
(entire fixture)
Circuiting pg. 4

BATTERY & EMERGENCY (_ _ _)

0 - None QS
FSB - Factory Select Battery QS
FSG - Factory Select ALCR
GI - Iota ETS DR
GB - Bodine GTD
1ILL - Iota 10W, Lithium, Self Testing
1PLL - Bodine 10W, Lithium, Self Testing QS
Battery and Emergency pg. 4

FINISH (_ _)

W - White QS
Finish pg. 5

FIXTURE OPTIONS[2] (_ _ _ _)

QS - QuickShip QS
TW - Through-wiring
CP - Chicago Plenum QS
AR - Air Return
AM - Antimicrobial Paint
FW6 - 6' Flex Whip QS
Fixture Options pg. 5

CONTROLS[3] (_ _ _)

DLMFC - Wattstopper DLM *(wired)*
DLMFS - Wattstopper LLLC *(wireless)*
SNSLM - Encelium SensiLUM *(wireless)*
LEVIS0 - Leviton Intellect Sensor *(wireless)*
ENL_ - Enlighted IOT *(wireless)*
ENL2_ - Enlighted 2-Wire IOT *(wireless)*
Controls pg. 6

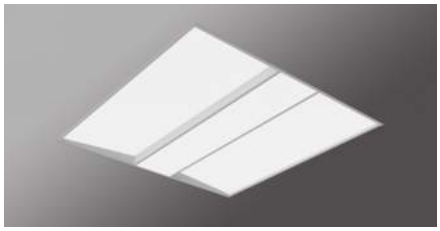
[1]When specifying SOURCE the first _ is for specifying either 8 - 80CRI or 9 - 90CRI. The ending _ _ are for specifying output, example HO - High Output. See output charts for more information. [2]If specifying QS, QS must be used in fixture options section of part number to qualify. [3]Controls can only be used with Single Circuit (1) or Emergency Circuit (E). See Controls chart on page 5 for driver options and more information.

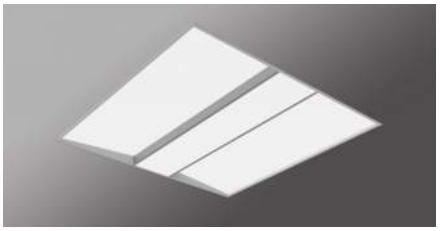
Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

Shielding

- Three piece acrylic diffuse lens
- Fully luminous housing with optimal glare control
- Highly reflective white reflectors maintain uniform lens brightness

W	S
Satine Lens with White Rails	Satine Lens with Silver Rails





Source

- Specify either 80 or 90 CRI
- Longer lead-time may apply for 90 CRI. Consult factory.
- 90 CRI = R9≥50

Custom Output- Lumens OR Wattage

CL_ _ _ _ _	Specify CRI, CCT and desired lumens (i.e. CL8351200)	*Specify lumens between standard offering listed below. Lumens are specified per color temp*
CW_ _ _ _ _	Specify CRI, CCT and desired wattage (i.e. CW94015)	*Specify watts between standard offering listed below*

80 CRI

	Color	Output	Watts	Shielding			
				W White Trim		**S** Silver Trim	
				Lumens	*LPW*	*Lumens*	*LPW*
830LO	3000K	Low	22.1	3308	150	3143	142
830MO	3000K	Middle	29.9	4410	147	4190	140
830HO	3000K	High	37.5	5484	146	5210	139
830VHO	3000K	Very High	55.9	7828	140	7437	133
835LO	3500K	Low	22.1	3322	150	3156	143
835MO	3500K	Middle	29.9	4429	148	4207	141
835HO	3500K	High	37.5	5507	147	5232	140
835VHO	3500K	Very High	55.9	7861	141	7468	134
840LO	4000K	Low	22.1	3411	154	3241	147
840MO	4000K	Middle	29.9	4547	152	4320	144
840HO	4000K	High	37.5	5655	151	5372	143
840VHO	4000K	Very High	55.9	8072	144	7668	137

90 CRI

927LO	2700K	Low	22.1	2743	124	2606	118
927MO	2700K	Middle	29.9	3657	122	3474	116
927HO	2700K	High	37.5	4548	121	4321	115
927VHO	2700K	Very High	55.9	6492	116	6167	110
930LO	3000K	Low	22.1	2810	127	2670	121
930MO	3000K	Middle	29.9	3746	125	3559	119
930HO	3000K	High	37.5	4659	124	4426	118
930VHO	3000K	Very High	55.9	6650	119	6317	113
935LO	3500K	Low	22.1	2933	133	2786	126
935MO	3500K	Middle	29.9	3909	131	3714	124
935HO	3500K	High	37.5	4862	130	4619	123
935VHO	3500K	Very High	55.9	6939	124	6592	118
940LO	4000K	Low	22.1	3011	136	2860	129
940MO	4000K	Middle	29.9	4013	134	3813	128
940HO	4000K	High	37.5	4991	133	4741	126
940VHO	4000K	Very High	55.9	7124	127	6768	121

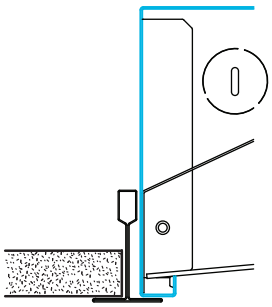
Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

Mounting

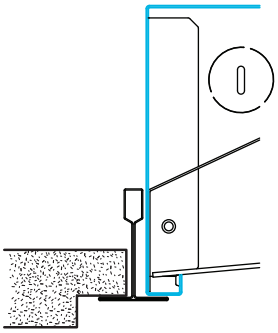
- TRAVERSE can be ordered for all grid types. See below for fixture placement in relation to the tile for each grid type
- Grid retention clips integral to housing and require mechanical attachment
- Tie off fixture to structure with retention wires
- Refer to installation instructions during installation
- Approved for dry/damp location
- Maximum fixture weight is 27.3lbs

G1

1" Grid Mount
Works with 15/16" grid ceiling types. See profile for fixture position in relation to ceiling grid and tile.



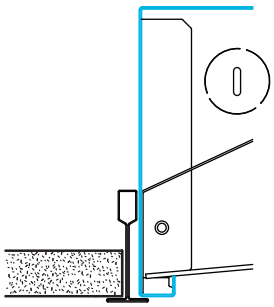
Standard Tile



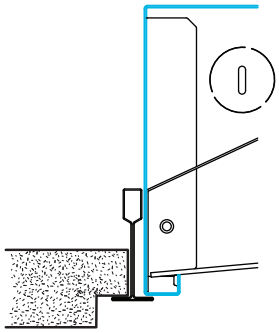
Tegular Tile

G9

9/16" Grid Mount
Works with 9/16" grid ceiling type. For tegular tile installations, fixture position will not be flush to the bottom of the tile. See tegular tile profile image below.



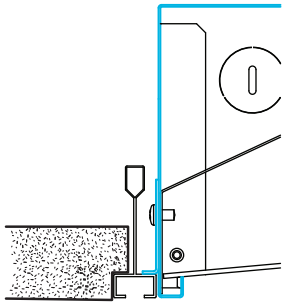
Standard Tile



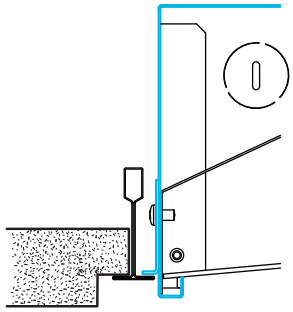
Tegular Tile

GS

Screw Slot Mounting
Works with screw slot and bolt slot grid ceiling types.



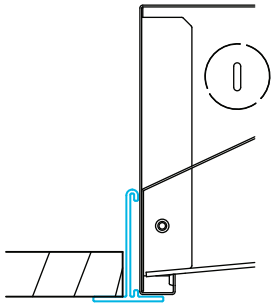
Standard Tile

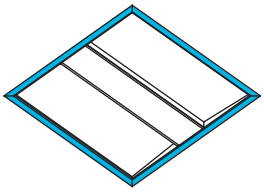


Tegular Tile

FL

Flange Kit
A separate flange kit is supplied for installations into inaccessible or drywall applications. Flange kit ships from factory uninstalled separately from fixture.





Voltage

- Some TRAVERSE configurations will not accommodate all voltage options; consult with factory

U	Universal
1	120 volt
2	277 volt
3	347 volt

Driver

- Standard Driver Option = FSD
- Driver Lifetime: 50,000 hours at 25°C ambient operating conditions
- For more Driver options, see Pinnacle Resource Guide
- Some TRAVERSE configurations will not accommodate all driver options; consult with factory

0-10V Drivers	
FSD	Factory Select Driver 1%, 0-10v
PL2	Advance Xitanium 1%, 0-10v
OL2	eldoLED Optotronic, 1%, 0-10v
OL4	eldoLED Optotronic 347v, 1% 0-10v, requires 347v option
EE1	eldoLED ECOdrive 1%, 0-10v, Logarithmic
EE2	eldoLED ECOdrive 1%, 0-10v, Linear
ES1	eldoLED SOLOdrive 0.1%, 0-10v, Logarithmic
ES2	eldoLED SOLOdrive 0%, 0-10v, Linear
OL5	eldoLED Optotronic 1%, 0-10v, AUX
DALI Drivers	
EE3	eldoLED ECOdrive .1%, DALI, Logarithmic
OD1	eldoLED Optotronic 1%, DEXAL
PR1	Advance Xitanium SR, DALI 2, Self powered link
Lutron Drivers	
LH1	Lutron Hi-lume Soft-on, Fade-to-black 1%, EcoSystem, LDE1

Circuiting

- Select fixture circuiting from options below
- Some TRAVERSE configurations will not accommodate all circuiting options; consult with factory

1	Single Circuit
E	Emergency Circuit only
N	Night Light Circuit only

Battery & Emergency

- Select battery or emergency options if required
- Battery duration is 90 minutes
- Test button is integral to fixture
- For more Battery options, see Pinnacle Resource Guide

0	No Battery
FSB	Factory Select Battery 10w, Integral Lithium
FSG	Factory Select ALCR Emergency Control Device, UNV
GI	Iota ETS-DR, Emergency Control Device, UNV
GB	Bodine GTD, Emergency Control Device, 120v or 277v
1ILL	Iota 10w, Integral Lithium, Self Testing
1PLL	Bodine 10w, Integral Lithium, Self Testing

For Approximate Battery Lumen Output

- Multiply battery wattage X fixture LPW shown on Lumen Table
- 10 (watts) x 92.3 (LPW) = 923 battery lumen output

Battery & Emergency Ordering Examples

- Single circuit, 10w integral battery — Ordering Code: 1-1FSB
- Emergency circuit only, 10w integral battery — Ordering Code: E-1PLL

Finish

- Powder-coat white painted finish

W	White

Fixture Options

- Additional options to enhance the fixture and finish of the product

QS	QuickShip
TW	Through-Wiring
CP	Chicago Plenum
AM	Antimicrobial Paint
AR	Air Return
FW6	Flex Whip 6′

Quick Ship

Shielding	Output	Mounting	Voltage	Driver	Circuiting	Battery	Finish	Options
10-Day								
W White Rails	80 CRI, All color temperatures, all lumen packages *See pg 2*	**G1** 1″ Grid **G9** 9/16″ Grid **GS** Screw Slot	**U** Universal **1** 120v **2** 277v	**FSD** Factory Select Driver *(1%, 0-10v)*	**1** Single **E** Emergency **N** Night Light	**0** None **FSB** Factory Select Battery	**W** White	**CP** Chicago Plenum **FW6** Flex Whip 6′ 18-gauge

Consult Factory for projects that are larger than 200 units.

Controls

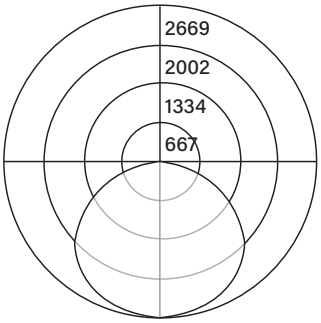
- Pinnacle Lighting offers easy to specify network control solutions that connect to an intelligent centralized system to maximize lighting energy efficiencies or integral sensors for individual fixture control
- Pinnacle Lighting fixtures ship technology ready; commissioning by others
- Controls can only be used with Single Circuit (**1**) or Emergency Circuit (**E**)
- Contact factory for any non-standard configurations for layout, placement, or EM options
- Must specify required driver in Driver section

	Solution	Components	Network/Sensor	Connection	Required Drivers	Limitations
DLMFC	Legrand Wattstopper DLM	LMFC-011	Digital Lighting Management (DLM)	Wired, two RJ45 ports	OL2	Not available with Battery
DLMFS	Legrand Wattstopper LLLC	LMFS-601-W / LMFI-111	Wireless DLM Fixture Sensor	Wireless	OD1, PR1I or 0-10v	0-10v requires interface
SNSLM	Encelium SensiLUM	EN-CLM-PIR-DD-ZB	Encelium, Daylight/PIR Occupancy	Wireless	OD1, OL5	
LEVIS0	Leviton Intellect Sensor	ZL07S-N00	Leviton Intellect, Daylight/PIR Occupancy	Wireless	OL5	
ENLI	Enlighted IOT	SU-5E-IOT	Enlighted, Daylight/PIR Occupancy	Wireless	ANY 0-10V	
ENLC	Enlighted Connected Lighting	SU-5E-CL	Enlighted, Daylight/PIR Occupancy	Wireless	ANY 0-10V	
ENL2I	Enlighted 2-Wire IOT	KIT-SU-5E-D-IOT	Enlighted, Daylight/PIR Occupancy	Wireless	OD1, PR1	
ENL2C	Enlighted 2-Wire Connected Lighting	KIT-SU-5E-D-CL	Enlighted, Daylight/PIR Occupancy	Wireless	OD1, PR1	

Photometrics

Satine Lens

Test #	F241200
Catalog #	TR24-A-835
Lumens	7633 lm
Watts	52.8 W
Efficacy	145 LPW



Candela Distribution

Vert Angle	Horizontal Angle 0	22.5	45	67.5	90
0	2666	2666	2666	2666	2666
5	2651	2644	2655	2659	2658
10	2612	2606	2618	2626	2626
15	2546	2543	2561	2574	2578
20	2458	2457	2483	2507	2517
25	2343	2349	2389	2427	2443
30	2210	2223	2279	2335	2357
35	2057	2075	2150	2222	2252
40	1887	1910	1999	2083	2118
45	1701	1728	1825	1913	1948
50	1508	1534	1630	1712	1743
55	1303	1329	1415	1483	1506
60	1097	1114	1183	1233	1248
65	882	894	941	974	982
70	675	680	706	721	726
75	465	466	478	482	482
80	274	270	271	267	263
85	111	108	94	93	89
90	6	1	7	3	8

Luminance Data (cd/sq.m)

Angle In Degrees	Average 0-Deg	Average 45-Deg	Average 90-Deg
45	3234	3469	3703
55	3053	3316	3529
65	2804	2994	3123
75	2417	2483	2503
85	1710	1455	1380

For all available IES files, please visit our website at pinnacle-ltg.com. Photometry testing in accordance to IESNA-LM-79-08 at an NVLAP accredited testing laboratory. Testing conducted at 25°C ambient conditions

Approvals & Certifications

Construction: Formed 24 gauge cold rolled steel housing. Highly reflective die-formed reflectors maintain uniform lens brightness. Wiring access on both sides and top of housing. Housing designed to maintain optimal temperature of LED diodes and driver and allow for room-side maintenance of lens, driver and LED boards.

Shielding: 3 piece diffuse lens with center spine creating a fully luminous housing with optimal glare control. Available with white or silver lens side rails.

Mounting: Designed to install into acoustical grid and inaccessible ceilings. Specify G1, G9 or GS for acoustical grid ceiling. Specify FL for inaccessible ceilings. Grid retention clips integral to housing and require mechanical attachment. Tie off fixture to structure with retention wires. Maximum fixture weight is 27.3 lbs.

LED: 25°C test environment. Lumen output/wattage has a margin of +/- 5%. Luminaire configurations tested in accordance with IES LM-79. Diodes tested in accordance with IES LM-80. Lifetime calculated using IES TM-21. Minimum lifetime greater than 60,000 hours. Lifetime Projection L70 = 275,000 hours and L90 = 83,000 hours. MacAdam 3-Step Ellipses. For all available IES files, please visit our website at pinnacle-ltg.com.

Color & Lumen Output: Not all lumen packages available. Four lumen packages available. Low (LO), Medium (MO), High (HO) and Very High (VHO). Custom outputs are available. Specify custom lumens or watts between standard offering listed on CRI, CCT & Output page. 80 CRI is available for 3000K, 3500K, and 4000K. 90 CRI is available for 2700K, 3000K, 3500K and 4000K. 90 CRI = R9≥50.

Voltage: Universal (U), 120 volt (1) and 277 volt (2) options available. Some TRAVERSE configurations will not accommodate all voltage options; consult with factory.

Driver: Standard Driver Option is Factory Select Driver 0-10V, 1% = FSD. Electronic driver, Power factor is >0.9 with a THD <20%. Driver Lifetime: 50,000 hours at 25°C ambient operating conditions. Ambient operating range: -20°F/-30°C to 87°F/30C. For more driver options, see Pinnacle Resource Guide. Some TRAVERSE configurations will not accommodate all driver options.

Circuiting: Select from single circuit (1), Emergency circuit (E) or Night Light circuit (N). Some TRAVERSE configurations will not accommodate all circuiting options, consult with factory.

Battery & Emergency: Select battery or emergency options if required. If battery or emergency option is not required, enter 0. Battery duration is 90 minutes as standard. Test button is integral to fixture. For more Battery options, see Pinnacle Resource Guide.

Finish: Powder coat white painted finish.

Controls: DLM utilizes wired network connections for digital control through switching and dimming. ENCELIUM SensiLUM sensor provides wireless control, daylight harvesting and PIR occupancy using 0-10V, DEXAL or SR LED drivers. Leviton Intellect sensor provides wireless control, daylight harvesting and PIR occupancy detection using 0-10V, DEXAL or SR LED drivers. Enlighted Smart Sensor provides multi-functionality including daylight harvesting and PIR occupancy; for IOT or Connected platform using 0-10V, DEXAL or SR LED drivers.

Labels: UL and cUL 1598 listed. LO, MO, HO and VHO lumen packages are IC Rated. Approved for dry/damp location unless otherwise noted.

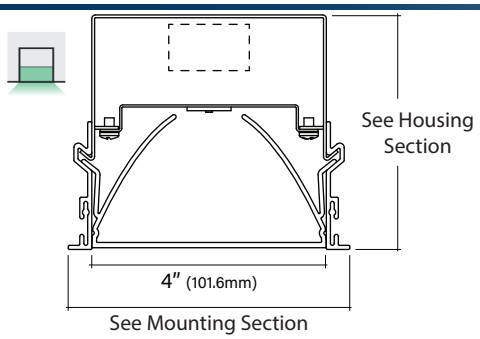
Fixture Weight: 27.3 lbs maximum.

Warranty: TRAVERSE LED offered with a 5-year limited warranty. Covers LED, driver and fixture.

PINNACLE ARCHITECTURAL LIGHTING®

Project Name _____

Date _____ Type _____



EDGE EV4DPM

4" Recessed Perimeter

Key Features

- Extruded aluminum trim with formed cold rolled 20 gauge steel back box housing
- 5-year limited warranty covers LED, driver and fixture
- ETL Listed conforming to UL1598 in US and CSA 250 in Canada
- Approved for dry/damp location unless otherwise noted
- Maximum fixture weight is 15lbs per 4ft fixture
- Room-Side Maintenance for LED system
- Buy American Act compliant
- Indigo-Clean available
- Product transparency with third-party verified Living Building Challenge (LBC) Declared

QUICKSHIP Declare. Third Party Verified

Example Part #: EV4DPM2-HE-830HO-26'-G1-U-FSD-1-0-W

HOUSING	SHIELDING	SOURCE	LENGTH OR PATTERN	MOUNTING	VOLTAGE	DRIVER	CIRCUITING	BATTERY & EMERGENCY	FINISH	FIXTURE OPTIONS	CONTROLS
_ _	_ _ _ _ _ _		_ _ _ _ _ _							_ _ _ _ _ _	

HOUSING

EV4DPM - Edge 4, Perimeter QS
EV4DPM2 - Edge 4, Perimeter, 2" Regress QS
EV4DPM3 - Edge 4, Perimeter, 3" Regress QS
EV4DPM4 - Edge 4, Perimeter, 4" Regress QS
MOD - Modifications Available
Housing pg. 2

SHIELDING

A - Satine Lens QS
HE - High Efficiency Lens QS
R - Regress Lens
WHE - Asymmetric Lens QS
Shielding pg. 2

SOURCE[1] QS

_27_ _ - 2700K
_30_ _ - 3000K
_35_ _ - 3500K
_40_ _ - 4000K
CL_ _ _ _ _ _ - Custom Lumens
CW_ _ _ _ _ _ - Custom Watts
MOD - Mod options available
Lumen Output pg. 2-3

LENGTH OR PATTERN[2] QS

_ _ - Individual Fixture
_ _ - Continuous Row
SI _ - Inside Square
SO _ - Outside Square
RI _ x _ - Inside Rectangle
RO _ x _ - Outside Rectangle
UI _ x _ - Inside U Shape
UO _ x _ - Outside U Shape
LI_ x _ - Inside L Shape
LO_ x _ - Outside L Shape
Length pg. 3

MOUNTING

G1 - 1" *(15/16")* T Bar QS
G9 - 9/16" T Bar QS
GB - 9/16" Bevel T Bar
GS - Screw Slot T Bar QS
FL - 1/2" Flange QS
NF - Non Flange QS
SF - Spackle Flange QS
MOD - Mod options available
Mounting pg. 4

VOLTAGE

U - Universal QS
(120 thru 277V)
1 - 120V QS
2 - 277V QS
3 - 347V
Voltage pg. 4

DRIVER

FSD - Factory Select Driver *(1%, 0-10v)* QS
PL2 - Advance Xitanium *(1%, 0-10v)*
OL2 - eldoLED Optotronic *(1%, 0-10v)*
OL4 - eldoLED Optotronic 347v *(1%, 0-10v)*
EE1 - eldoLED ECOdrive *(1%, 0-10v)*
ES1 - eldoLED SOLOdrive *(0.1%, 0-10v)*
LH1 - Lutron Hi-lume *(1%, EcoSystem)*
PS1 - Advance Xitanium *(50%/100%)*
MOD - Mod options available
Driver pg. 5

CIRCUITING

1 - Single Circuit QS
M - Multi Circuit
E - Emergency QS
(entire fixture)
N - Night Light QS
(entire fixture)
Circuiting pg. 5

BATTERY & EMERGENCY[3]

0 - None QS
_FSB - Factory Select Battery QS
_FSG - Factory Select ALCR
_GB - Bodine GTD
_GI - Iota ETS DR
_IC - Iota 10W *(CEC Listed)*
_P - Bodine 10W
_E - Emergency Circuit Section
_N - Night Light Circuit Section
_L - Life Safety Circuit Section
Battery and Emergency pg. 5-6

FINISH

W - White QS
S - Metallic Silver
BL - Textured Black
BR - Bronze
GR - Graphite
CC - Custom Color
Finish pg. 6

FIXTURE OPTIONS[4]

QS - Quick Ship QS
CP - Chicago Plenum QS
GLR - Internal Fast Blow Fuse QS
FIL- Field Cut Illuminated Extension QS
DSP - Customer Supplied Battery/Driver/Sensor
MOD - Mod options available
Fixture Options pg. 6

CONTROLS[5]

MOD - Mod options available
Controls pg. 7

[1]When specifying SOURCE the first _ is for specifying either **8** - 80CRI, **9** - 90CRI. The ending _ _ are for specifying output, example **HO** - High Output. See output charts for more information. [2]Individual fixtures come in **2', 3', 4', 5', 6', 7'** & **8'** lengths. Continuous row come in 1/8" increments. [3]Enter quantity for Battery and Emergency, Example 2P. [4]**QS** must be used in part number when QuickShip. [5]Controls can only be used with Single Circuit (1) or Emergency Circuit (E). See Controls chart on page 5 for driver options and more information.

Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

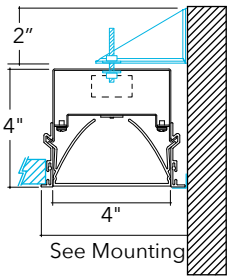
EDGE EV4DPM Recessed Perimeter

Housing

- Mounting bolt allows for adjustability of mount height. If fixture is flushed to mount bracket, distance to ceiling would be bracket height (2") + fixture height (dependent on regress).

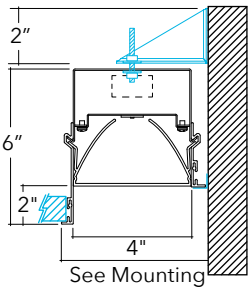
EV4DPM

Edge 4, Perimeter



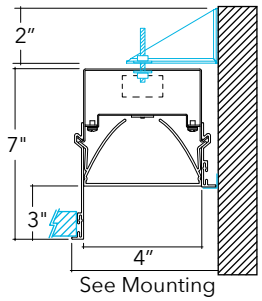
EV4DPM2

Edge 4, Perimeter
2" Regress



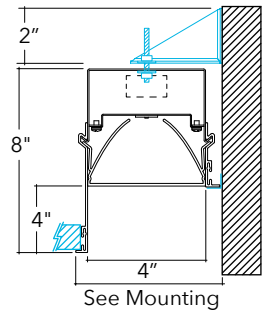
EV4DPM3

Edge 4, Perimeter
3" Regress



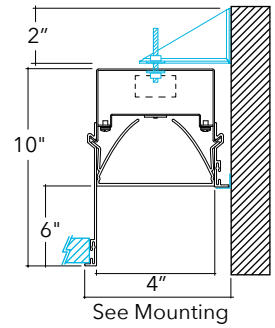
EV4DPM4

Edge 4, Perimeter
4" Regress



MOD
EV4DPM6

Edge 4, Perimeter
6" Regress

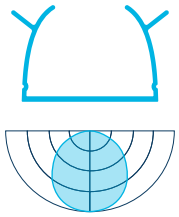


Shielding

- Regress Lens option uses housing with backbox. Back box does not impact mounting. see detail.
- Asymmetric Lens option recommended for use pointing away from wall.
- Regress Lens option not available with corners.

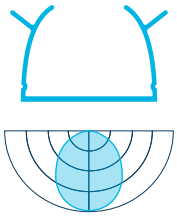
A

Satine Lens



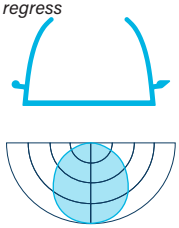
HE

High Efficiency



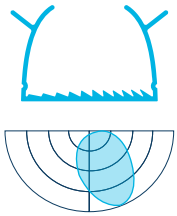
R

Regress
1-1/8" regress

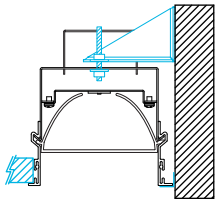


WHE

Asymmetric



Regress Detail



Source: White LED[1]

- Specify either 80 or 90 CRI
- Longer lead-time may apply for 90 CRI. Consult factory
- 90 CRI = R9≥50
- LPW and watts/ft based off 47" fixture size.

Custom Output - Lumens OR Wattage

CL _____	Specify CRI, CCT and desired lumens (i.e. CL835500)	*Specify lumens between standard offering listed below. Lumens are specified per color temp*
CW_____	Specify CRI, CCT and desired wattage (i.e. CW9407)	*Specify watts between standard offering listed below*

80 CRI

	Color	Lumens per foot	Shielding[1] A Satine		HE High Efficiency		R Regress		WHE Asymmetric	
			LPW	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*
830	3000K	500	114	4.4	126	4.0	103	4.9	123	4.1
830HO		750	114	6.6	130	5.8	103	7.3	127	5.9
830VHO		1000	117	8.5	131	7.6	104	9.6	130	7.7
835	3500K	500	118	4.3	130	3.9	104	4.8	127	4.0
835HO		750	117	6.4	134	5.6	106	7.1	131	5.7
835VHO		1000	120	8.3	136	7.4	107	9.4	132	7.6
840	4000K	500	118	4.3	130	3.9	104	4.8	127	4.0
840HO		750	117	6.4	134	5.6	106	7.1	131	5.7
840VHO		1000	120	8.3	136	7.4	107	9.4	132	7.6

90 CRI

927	2700K	500	94	5.3	106	4.7	83	6.0	103	4.8
927HO		750	96	7.8	108	6.9	85	8.8	105	7.1
927VHO		1000	95	10.5	108	9.2	N/A		107	9.4
930	3000K	500	103	4.9	115	4.3	91	5.5	113	4.4
930HO		750	103	7.3	115	6.5	92	8.1	112	6.7
930VHO		1000	104	9.6	118	8.5	92	10.9	116	8.7
935	3500K	500	103	4.9	115	4.3	90	5.5	112	4.5
935HO		750	102	7.3	115	6.5	92	8.1	112	6.7
935VHO		1000	104	9.6	118	8.5	92	10.9	115	8.7
940	4000K	500	103	4.9	115	4.3	90	5.5	112	4.5
940HO		750	102	7.3	115	6.5	92	8.1	112	6.7
940VHO		1000	104	9.6	118	8.5	92	10.9	115	8.7

[1]LPW and watts/ft based off 47" fixture size.

Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

Direct Source: MOD Options

- Specify **MOD** in the part number for any of the below options
- All **RGB_** Source Options will require specific driver and control
- Consult factory for **MOD** specification details, pricing, and lead-time information

		Required Driver	Required Control
MOD	Color Changing RGB LED	EC1	DMX
	Color Changing RGB-W LED	EC1	DMX
	Color Changing RGB-A LED	EC1	DMX
	2 Channel Tunable White	Various	Various

Length

- All individual units cannot be joined, end trims are factory installed and cannot be removed
- Refer to Pattern section for specification and ordering options
- Continuous Rows are made up of even and odd length fixtures; designed to fall on-grid

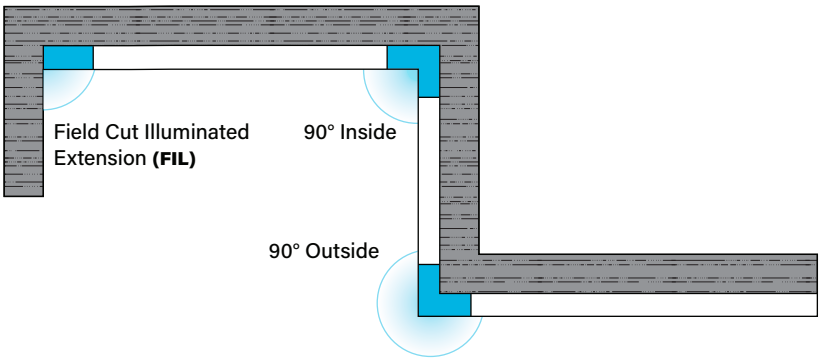
2	3	4	5	6	7	8	–
Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Cont. Run *Specify nominal overall row length to the 1/8"*

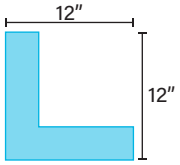
23" (584.2mm)
35" (889mm)
47" (1193.8mm)
59" (1498.6mm)
71" (1803.4mm)
83" (2108.2mm)
95" (2413mm)
Specify to the 1/8"

Pattern

- Specify pattern shape and overall dimensions (includes corner dimensions)
- 90 degree horizontal corners are 12"x12" (overall, outside dimension)
- Use with Field Cut Illuminated extensions (**FIL**) to fit to wall to wall dimensions
- Not all drivers available with all patterns; consult factory
- Only available with A of HE lens

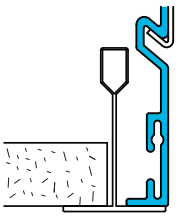
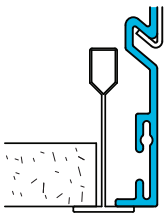
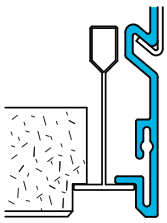
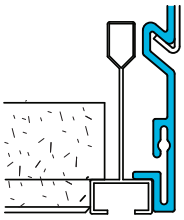
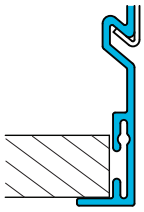
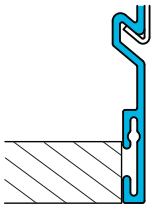
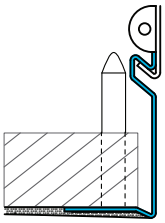
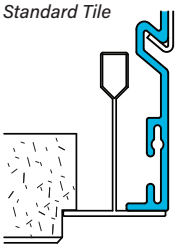
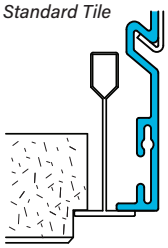
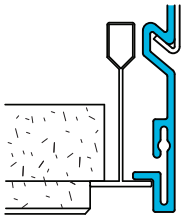
SI_	SO_	RI_x_	RO_x_	UI_x_x_	UO_x_x_	LI_x_	LO_x_
Square, Inside (**SI**) or Outside (**SO**) *Provide overall length dimension for each fixture leg*		Rectangle, Inside (**RI**) or Outside (**RO**) *Provide overall length dimension for each fixture leg*		U-Shape, Inside (**UI**) or Outside (**UO**) *Provide overall length dimension for each fixture leg*		L-Shape, Inside (**LI**) or Outside (**LO**) *Provide overall length dimension for each fixture leg*	





Mounting

- Individual units cannot be joined, end trims are factory installed and cannot be removed
- Designed to install into acoustical grid and inaccessible ceilings
- Grid retention brackets integral to housing and require mechanical attachment
- Each housing contains 4 grid retention brackets
- Tie off fixture to structure with retention wires
- Approved for dry/damp location unless otherwise noted
- Details shown are room side mounting, wall side mounting will be FL flange on wall mount trim

G1	G9	GB	GS	FL	NF	SF
1" (15/16") T-Bar *Flange to Flange:* *4-15/16" (125.7mm)*	9/16" T-Bar *For tegular tile installations, fixture position will not be flush to the bottom of the tile* *Flange to Flange:* *4-15/16" (125.7mm)*	9/16" T-Bar *Rail has bevel edge details. For tegular tile installations, fixture position will be flush to the bottom of the tile* *Flange to Flange:* *4-15/16" (125.7mm)*	Screw Slot & 9/16" T-Bar *For 9/16" installations with tegular tile, fixture position will be flush to the bottom of the tile* *Flange to Flange:* *4-15/16" (125.7mm)*	Exposed Standard 1/2" Flange Detail *Flange to Flange:* *5-1/8" (129.5mm)*	Metal Pan or Millwork *Flange to Flange:* *4-3/4" (120.6mm)*	Drywall, Flangeless Detail *Flange to Flange:* *5-1/2" (140.9mm)*
 *Standard Tile*	 *Standard Tile*	 *Tegular Tile*	 *Tegular Tile*			
 *Tegular Tile*	 *Tegular Tile*		 *Tegular Tile*			

Mounting: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Alternative Ceiling Solutions

Voltage

- Some EV4D configurations will not accommodate all voltage options; consult with factory

U	Universal
1	120 volt
2	277 volt
3	347 volt

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Driver

- Standard Driver Option = FSD
- Driver Lifetime: 50,000 hours at 25°C ambient operating conditions
- For more driver options see Pinnacle Resource Guide
- Some EV4D configurations will not accommodate all driver options; consult with factory

0-10V Drivers	
FSD	Factory Select Driver 1%, 0-10v
PL2	Signify Advance Xitanium 1%, 0-10v
PL4	Advance Xitanium 347v 1%, 0-10v, requires 347v
OL2	eldoLED Optotronic, 1%, 0-10v
OL4	eldoLED Optotronic 347v, 1% 0-10v, requires 347v option
EE1	eldoLED ECOdrive 1%, 0-10v Logarithmic
EE2	eldoLED ECOdrive 1%, 0-10v Linear
ES1	eldoLED SOLOdrive 0-10v, 0.1% Logarithmic
ES2	eldoLED SOLOdrive 0-10v, 0% Linear
OL5	eldoLED Optotronic 1%, 0-10v, AUX
PL5	Advance Xitanium 1%, 0-10v, AUX
DALI Drivers	
EE3	eldoLED ECOdrive .1%, DALI (logarithmic)
ES3	eldoLED SOLOdrive .1%, DALI (logarithmic)
OD1	eldoLED Optotronic 1%, DEXAL
Lutron Drivers	
LH1	Lutron Hi-lume Soft-on, Fade-to-black 1%, EcoSystem, LDE1
Alternate Drivers	
PS1	Signify Advance Xitanium Step Dimming 50%/100%
EH1	ELV 120v only, 0-10v universal

Driver: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	POE or DC Power

How to Specify Circuiting, Battery and Emergency

1

- Select fixture circuiting from options below
- Some EV4D configurations will not accommodate all circuiting options, consult with factory

Circuiting

1	Single Circuit
M	Multi Circuit *(Not available with controls)*
E	Emergency Circuit only
N	Night Light Circuit only

2 + **3**

- Battery and emergency section options are available in addition to fixture circuit
- Select battery and emergency section options below; factory shop drawing required
- Some EV4D configurations will not accommodate all circuiting options, consult with factory

Battery and/or Emergency *If Required*

0	No battery or specific emergency section required

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Battery

- Select battery section type if required, indicate total QTY. *Example 2P*
- 90 minute battery runtime; test button location dependent on configuration, consult factory
- No battery option available for 2′ lengths
- Entire fixture is on battery for lengths up to 5′
- Largest reflector section is on battery for 6′, 7′ and 8′ housing lengths
- For more battery options available, see Pinnacle Resource Guide

0	No Battery
_FSB	Factory Select Battery (10w option)
_FSBST	Factory Select Battery (10w, Self Testing)
_ILL	Iota 10w Integral Lithium, Self Testing
_PLL	Bodine 10w Integral Lithium, Self Testing

For Approximate Battery Lumen Output
- Multiply battery wattage X fixture LPW shown on Lumen Table
- 92.3 (LPW) x 10 (watts) = 923 battery lumen output

Battery OR Emergency Ordering Examples
- Single circuit, 10w Integral Battery — Ordering Code: 1-1FSB
- Emergency only, 10w Integral Battery — Ordering Code: E-1FSB
- Single circuit, GTD required — Ordering Code: 1-1GB

Emergency

- Select emergency section type if required, indicate total QTY. *Example 1E*
- Combine battery and emergency section ordering codes if both options are selected

_FSG	Factory Select ALCR Emergency Control Device, UNV
_GI	Iota ETS-DR, Emergency Control Device, UNV
_GB	Bodine GTD, Emergency Control Device, 120v or 277v
_E	Emergency circuit section
_N	Night Light circuit section
_L	Life Safety circuit section NO THROUGH WIRE

Finish

- Standard powder-coat textured white, metallic silver, textured black, graphite or bronze painted finish; consult factory for chip of standard paint finishes
- Selecting a fixture finish other than white may impact lumen output; consult factory for more information

W	White
S	Metallic Silver
BL	Textured Black
GR	Graphite
BR	Bronze
CC	Custom Color

Fixture Options

- Additional options to enhance the fixture and finish of the product
- FIL has 2″ min - 12″ max length
- FIL Option angle range is 40° to 90°
- FIL Option is not IC rated

QS	Quick Ship
CP	Chicago Plenum
GLR	Internal Fast Blow Fuse
DSP	Customer Supplied Battery/Driver/Sensor
FIL	Field Cut Illuminated Extension

Quick Ship

Shielding	Source	Mounting	Voltage	Driver	Circuiting	Battery	Finish	Options
10-Day								
A **HE** **WHE**	80 CRI, all color temperatures, all lumen packages *See pg 2*	**G1** 1″ T-Bar **G9** 9/16″ T-Bar **GS** Screw Slot **FL** 1/2″ Flange **NF** Flangeless **SF** Spackle Flange	**U** Universal (120-277) **1** 120V **2** 277V	**FSD** Factory Select Driver *(1%, 0-10v)*	**1** Single Circuit **E** Emergency **N** Night Light	**0** None **FSB** Factory Select Battery	**W** White	**CP** Chicago Plenum **GLR** Fast Blow Fuse **FIL** Illuminated Extensions

All lengths and continuous rows up to 1,000 ft OR 150 individual fixtures. Consult factory for larger projects.

Fixture Options: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Remote Driver

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Direct Source: MOD Options

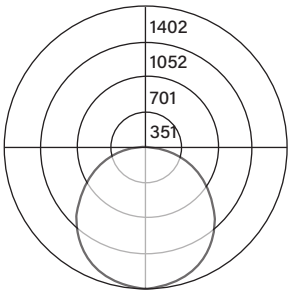
- Specify **MOD** in the part number for any of the below options
- **Control** Options may require specific driver. Refer to the chart below
- Consult factory for **MOD** specification details, pricing, and lead-time information

		Required Driver
MOD	Legrand Wattstopper DLM	OL2, OL4
	Encelium Sensilum	OD1, OL5
	Acuity nLight Air Wireless Connected	EE6, ES6

Photometrics

Satine Lens

Test #	ITL91432
Catalog #	EV2D-A-840VHO-4
Lumens	4020 lm
Watts	34.7 w
Efficacy	116 LPW



Candela Distribution

Vert Angle	Horizontal Angle 0	22.5	45	67.5	90
0	1400	1400	1400	1400	1400
5	1393	1395	1397	1398	1399
10	1379	1382	1382	1379	1381
15	1348	1344	1350	1350	1348
20	1306	1298	1306	1307	1304
25	1253	1245	1253	1254	1247
30	1191	1178	1185	1184	1183
35	1112	1104	1112	1108	1105
40	1030	1023	1029	1027	1024
45	940	932	935	932	930
50	839	834	836	833	830
55	734	730	730	729	727
60	624	618	619	618	615
65	507	504	503	501	503
70	388	386	387	388	387
75	269	268	271	273	274
80	156	160	164	166	168
85	65	66	70	73	73
90	0	0	0	0	0

Luminance Data (cd/sq.m)

Angle In Degrees	Average 0-Deg	Average 45-Deg	Average 90-Deg
45	10950	10892	10833
55	10541	10483	10440
65	9882	9804	9804
75	8561	8625	8720
85	6143	6616	6899

For all available IES files, please visit our website at pinnacle-ltg.com. Photometry testing in accordance to IESNA-LM-79-08 at an NVLAP accredited testing laboratory. Testing conducted at 25°C ambient conditions.

Applications & Certificates

Housing: Formed cold-rolled 20 gauge steel housing. Highly reflective die-formed white painted steel reflector.

Shielding: Diffuse snap-in acrylic lens, removable for maintenance.

Mounting: EDGE is designed to install into acoustical grid and inaccessible ceilings. Specify GX, FL, SF, NF, runs designed to fall on-grid. Consult factory for detailed installation instructions. Maximum fixture weight is 15lbs per 4' fixture.

White LED: 25°C test environment. Lumen output/wattage has a margin of +/- 5%; 2' or 3' lengths may have a greater wattage deviation. Luminaire configurations tested in accordance with IES LM-79. Diodes tested in accordance with IES LM-80. Lifetime calculated using IES TM-21. Minimum lifetime greater than 60,000 hours. TM-21-21 Lifetime Rating L70 = >72,000 hours, L90 = 68,400 hours. MacAdam 3-Step Ellipses. For all available IES files, please visit our website at pinnacle-ltg.com.

CRI, CCT & Lumen Output: Not all lumen packages available. Three lumen packages available. Standard, High (HO) and Very High (VHO). Custom outputs are available. Specify custom lumens or watts between standard offering listed on CRI, CCT & Output page. 80 CRI is available for 3000K, 3500K, and 4000K. 90 CRI is available for 2700K, 3000K, 3500K and 4000K. 90 CRI = R9≥50.

Voltage: Universal (U), 120 volt (1), 277 volt (2) and 347 volt (3) options available. Must specify PL4 or OL4 in Driver section when 347 volt (3) is selected. Some EDGE configurations will not accommodate all voltage options; consult with factory.

Driver: Standard Driver Option is Factory Select Driver 0-10V, 1% = FSD. Electronic driver, Power factor is >0.9 with a THD <20%. Driver Lifetime: 50,000 hours at 25°C ambient operating conditions. Ambient operating range: -20°F/-30°C to 94°F/35°C. For more driver options, see Pinnacle Resource Guide. Some EDGE configurations will not accommodate all driver options.

Circuiting: Select from single circuit (1), Multi circuit - For multiple circuiting and zone control, requires factory shop drawing (M), Emergency circuit (E), Life Safety (L) or Night Light circuit (N). For emergency circuiting situations that require no through wire or circuit separation, Life Safety Circuit should be selected. This will provide a separate power feed and only the Life Safety Circuit in that section. Some EDGE configurations will not accommodate all circuiting options; consult with factory.

Battery & Emergency: Select battery or emergency options if required. If battery or emergency option is not required, enter 0. Battery duration is 90 minutes as standard. Test button location dependant on configuration, consult factory. For more Battery options, see Pinnacle Resource Guide.

Finish: Standard powder-coat textured white, metallic silver, textured black, graphite or bronze painted finish; consult factory for chip of standard paint finishes or for additional custom color and finish options.

Controls: Mod options available, consult with factory.

Labels: UL and cUL 1598 listed. Standard, HO and VHO lumen packages are IC Rated, approved for dry/damp location unless otherwise noted.

Sustainability: All models are Living Building Challenge (LBC) Declared with third-party verification. The Declare Label from ILFI provides transparent insights into materials, sourcing, and environmental impact, promoting informed, sustainable choices that benefit both people and the planet. View the label here.

Fixture Weight: Maximum fixture weight is 15lbs per 4' fixture.

Buy American Act Compliant

Warranty: EDGE LED offered with a 5-year limited warranty. Covers LED, driver and fixture.

gotham | I V O™

Luminaire Type:

Catalog Number:

IVO™ 4" Round Cylinders
Pendant Mount

ø5.5" x 9"

MOUNTING STYLES AND TRIM COLORS

Canopy with Recessed J-box (JBX)

Canopy with Surface J-box (JBX)

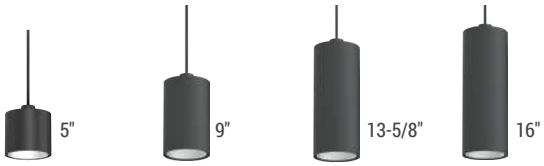
Conduit Cover Canopy with Surface J-box (JBXCC)

Surface Gear Box with Recessed J-Box (SGB)

Surface Gear Box with Surface J-Box (SGB)

Conduit Cover Surface Gear Box with Surface J-Box (SGBCC)

Cylinder Lengths

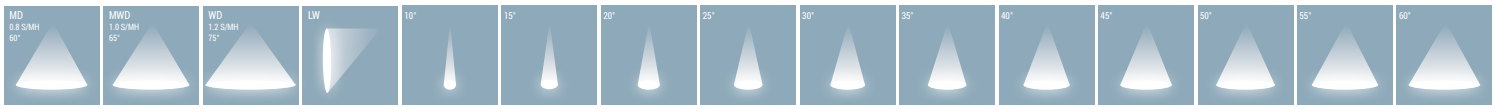


QUICK SPECIFICATIONS

Feature Set

- Perfect Color™ consistency within 1/2-step MacAdam Ellipse
- 45° visual cut-off angle to source (65° for 5″ tall)
- Bounding Ray™ optical design ensures no source image up to cut-off angle, minimizing glare
- Available with 10%, 1%, or 0.1% dim to dark
- Rigid Stems are field cuttable with no threading required
- Powered Mounting Cords are field cuttable and include integrated Aircraft Cable (patent pending) for mechanical support without visible cable
- 90% lumen maintenance at 55,000 hours
- Clean beams with soft transitions
- Batwing distributions with feathered edges to provide even illumination fixture-to-fixture
- Field changeable optics available every 5°
- Wet Location optional, covered ceiling

Distribution / Beam Angles



Superior Perfomance*

Nominal Lumens	05LM	07LM	10LM	15LM	20LM	25LM	30LM	35LM	40LM	45LM
Delivered Lumens	493	735	991	1486	1968	2447	2732	3313	3796	4236
Wattage	5.1	7.3	9.8	15.0	20.5	26.8	29.7	34.4	41.8	45.3
Lumens per Watt	96	100	101	99	96	91	92	96	91	94

*Based on Downlight performance: 3500K 80CRI MWD P AR LSS, for L9, L14, and L16. See Photometry section for Wall Wash performance. See IES files available online for L5 performanc

PRODUCT FAMILY

IVO 4" Round Product Family

Downlight

Lensed WW

Surface Cylinder

Pendant Cylinder

Wall Cylinder

Wall Adjustable Cylinder

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ORDERING INFORMATION

Luminaire Type:

Catalog Number:

EXAMPLE: IVO4CYL PC D 15LM 35K 80CRI MD MIN1 MVOLT ZT L5 JBX CAN C120 P AR LD DWH
EXAMPLE: IVO4CYL PC WW 20LM 35K 80CRI MIN1 MVOLT EZT L5 JBX CAN45 S10 LW BR LSS DBL

Series	Mounting Option	Function	Lumen Packages	Kelvin Temperature	Color Rendering Index	Distribution[4]
IVO4CYL IVO 4" Round Cylinder	**PC** Pendant Mount Cylinder	**D** Downlight **WW** Wall Wash	**05LM**[1] 500 Lumens **07LM** 700 Lumens **10LM** 1000 Lumens **15LM** 1500 Lumens **20LM** 2000 Lumens **25LM**[1] 2500 Lumens **30LM**[1] 3000 Lumens **35LM**[2] 3500 Lumens **40LM**[2] 4000 Lumens **45LM**[2] 4500 Lumens	**27K** 2700K **30K** 3000K **35K** 3500K **40K** 4000K **50K** 5000K	**80CRI** 80+ CRI **90CRI**[3] 90+ CRI, R9 50+ **95CRI**[3] 95+ CRI, R9 80+	Narrow / Flood[5] **10D** 10° **30D** 30° **50D** 50° **15D** 15° **35D** 35° **55D** 55° **20D** 20° **40D** 40° **60D** 60° **25D** 25° **45D** 45° General Illumination / Batwing **MD** Medium Batwing (0.8 s/mh, 60°) **MWD** Medium Batwing Wide (1.0 s/mh, 65°) **WD** Wide Batwing (1.2 s/mh, 75°)

Dimming Level	Voltage	Control Input	Cylinder Length	Mounting Style
MIN10 Min 10% Dim Level **MIN1** Min 1% Dim Level **DARK** Min 0.1% Dim Level, Dim-to-Dark	**MVOLT** Multi-Volt Input, 120V-277V **120** 120V Input **277** 277V Input **347**[6] 347V Input	**ZT**[7] Generic 0-10V **ELV**[8] Phase Dimming (Forward/Reverse) (120V only) **EZT** EldoLED 0-10V **DALI**[8] DALI-2 **DMX**[9,10] DMX **NLIGHT**[11] Wired controls by nLight **NLTAIR2**[11] Wireless controls by nLight **NLIGHTER**[11] Wired controls by nLight with UL924 listed emergency operation **NLTAIREM2**[11] Wireless controls by nLight with UL924 listed emergency operation	**L5** 5" Cylinder Body Length **L9** 9" Cylinder Body Length **L14** 13-5/8" Cylinder Body Length **L16** 16" Cylinder Body Length	**JBX** Integral driver, Recessed or Surface J-box **JBXCC** Integral driver, Surface J-box with conduit covers **SGB**[12] Surface Gear Box, Recessed or Surface J-Box **SGBCC**[12] Surface Gear Box, Surface J-box with conduit covers

Canopy Cover	Pendant Length / Type	Fusing	Emergency Pack[14]	Wet/IP Listing
CAN Canopy, 5° hang straight swivel **CAN45** Canopy, 45° hang straight swivel	**S2** 2ft x ø1/2" stem **S4** 4ft x ø1/2" stem **S6** 6ft x ø1/2" stem **S8** 8ft x ø1/2" stem **S10** 10ft x ø1/2" stem **S12** 12ft x ø1/2" stem **S16** 16ft x ø1/2" stem **S20** 20ft x ø1/2" stem **C120**[13] 10ft x ø5/16" cord **C180**[13] 15ft x ø5/16" cord **C240**[13] 20ft x ø5/16" cord	**(blank)** No Options **SF** Single Fuse, specify 120V or 277V	**(blank)** No Emergency Pack **E7WR** 7W Emergency battery pack, Constant Power, Title 20 Compliant, User selectable Self-Diagnostic, AC Activate with Remote Test Switch (Sidecar) **E10WR** 10W Emergency battery pack, Constant Power, Title 20 Compliant, User selectable Self-Diagnostic, AC Activate with Remote Test Switch (Sidecar) **E15WR** 15W Emergency battery pack, Constant Power, Title 20 Compliant with Remote Test Switch (Sidecar)	**(Blank)** Damp Location **WL**[15] Wet Location

Trim Style	Trim Color	Trim Finish[17]	Cylinder Color	
P[4] Open Parabolic Reflector **LW**[16] Lensed Wall Wash	**AR** Clear Anodized **BR** Black Anodized **GR** Gold Anodized **PR** Pewter Andozied **WTR** Wheat Anodized **WR**[17] White Paint **WRAMF**[17] White with Anti-Microbial Paint **WMR**[17] Soft White Paint **BZR**[17] Dark Bronze Paint **TRALTBD**[18] RAL Paint **TCPCTBD** Custom Paint	**LSS** Semi Specular **LS** Specular **LD** Matte Diffuse	**DWH** Gloss White **DBL** Matte Black **DNA** Gloss Natural Aluminum **DWHAMF** Gloss White Anti-Microbial **DMB** Matte Medium Bronze **DDB** Gloss Dark Bronze **DSS** Gloss Sandstone **DGC** Gloss Charcoal Grey **DTG** Gloss Tennis Green **DBR** Gloss Bright Red **DSB** Gloss Steel Blue	**DDBT** Textured Dark Bronze **DBLB** Textured Black **DWHG** Textured White **DBNH** Textured Bronze **DNAT** Textured Natural Aluminum **DSST** Textured Sandstone **DSPD** Textured Dark Grey **DSPE** Textured Green **DSPH** Textured Light Red **RALTBD**[18] RAL Paint **CPC** Custom Paint

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ORDERING NOTES

1. 05LM, 25LM or 30LM only available with ZT or ELV control inputs for L5 cylinder length.
2. 35LM, 40LM, and 45LM not available with L5 Cylinder Length.
3. 90CRI not available with 50K, 95CRI not available with 35K, 40K or 50K.
4. Not available with WW style function.
5. Not available with L5 cylinder length.
6. 347 only available with ZT control input. Min 07LM -Max 40LM. Not available with nLight, Emergency or SF options. Not available with L5 cylinder Length.
7. ZT not available with DARK
8. ELV only available with MIN1.
9. DALI and DMX only available with DARK.
10. DMX only available with SGB or SGBCC mounting. Not available with L5 cylinder length.
11. nLight controls are provided with each fixture and can be remote mounted or mounted to the junction box. Wired NLIGHT and NLIGHTER controls include nPS 80 EZ dimming pack. Wireless NLTAIR2 and NLTAIREM2 controls include rPP20 power pack.
12. Only available with DMX Control Input option.
13. Powered Mounting Cords are field cuttable. Not available with WW style function. Color is determined by Architectural Color: White for DWHG, DWH, DWHAMF; Black for DBL, DBLB; Gray for all other options.
14. Not available with 05LM, 25LM or 30LM with EZT or DALI control input for L5 cylinder length. Not available with 05LM with EZT or DALI control input for L9, L14 or L16 cylinder lengths.
15. Only available with JBX. Not available with DMX or Emergency options. Min 07LM-30LM max for ZT or ELV in L5 cylinder lengths. Min 07LM-Max 20LM for EZT or DALI in L5 cylinder lengths. 30LM max for ZT or ELV in L9, L14 or L16 cylinder lengths. 07LM-30LM max for EZT or DALI in L9, L14 or L16 cylinder lengths.
16. LW not available with D style function.
17. Trim finishes are not available with WR, WRAMF, WMR, and BZR trim colors.
18. Replace with applicable RAL number and finish when ready to order. See RAL BROCHURE for available color options.

ACCESSORIES — order as separate catalog numbers (shipped separately)

GCOLORS KIT	Architectural colors chip kit, consisting of powder-coat and plated finishes
GOTHAM IVO REFLECTOR COLOR KIT	Trim colors & finishes sample kit for standard IVO anodized and painted trim color options.
CYLJBOXADPT 4SQ2OCT __	4in Square J-box to 4in Octagonal J-box adaptor. Replace __ with Architectural Color or PRM for primed ready for field painting
CYLSTBL KIT	Stabilization Kit for securing pendant stem fixtures

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LENGTH AND TRIM OPTIONS

Cylinder Length

- Dimensions in inches [centimeters]
- L5 Cylinder has a 65° visual cut-off angle and trims and optics that are not interchangeable with the other Cylinder lengths

Trim Style

Parabolic (P)

Lensed Wall Wash (LW)

Optical Finish

Semi-Specular (LSS)

Specular (LS)

Matte Diffuse (LD)

Clear Anodized shown.

Trim Color

Clear Anodized (AR)

Soft White Matte Painted (WMR)

Black Anodized (BR)

White Gloss Painted (WR)

White Anti-Microbial Gloss Painted (WRAMF)

Wheat Anodized (WTR)

Dark Bronze Gloss Painted (BZR)

Gold Anodized (GR)

Pewter Anodized (PR)

Parabolic shown.

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ARCHITECTURAL COLORS

Textured Colors

Textured
White
(DWHG)

Textured
Black
(DBLB)

Textured
Aluminum
(DNAT)

Textured
Light Red
(DSPH)

Textured
Green
(DSPE)

Textured
Bronze
(DBNH)

Textured
Dark Bronze
(DDBT)

Textured
Dark Grey
(DSPD)

Textured
Sandstone
(DSST)

Gloss Colors

White
Gloss
(DWH)

Aluminum
Gloss
(DNA)

Bright Red
Gloss
(DBR)

Tennis Green
Gloss
(DTG)

Steel Blue
Gloss
(DSB)

Charcoal
Grey Gloss
(DGC)

Dark Bonze
Gloss
(DDB)

Sandstone
Gloss
(DSS)

AM White
Gloss
(DWH)

Matte Colors

Black
Matte
(DBL)

Medium Bronze
Matte
(DMB)

Note: These colors were carefully reproduced to give as true a depiction as possible of the finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please contact a Gotham representative for an Architectural Color Chip Kit (GCOLORS KIT), consisting of Powder-Coated and Plated Finishes.

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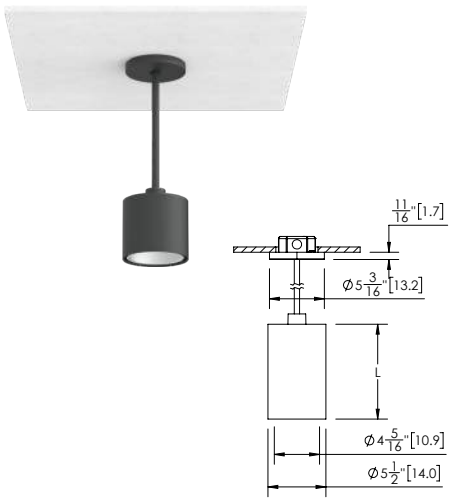
DIMENSIONAL DATA

Pendant Rigid Stem and Cord Mounting Options

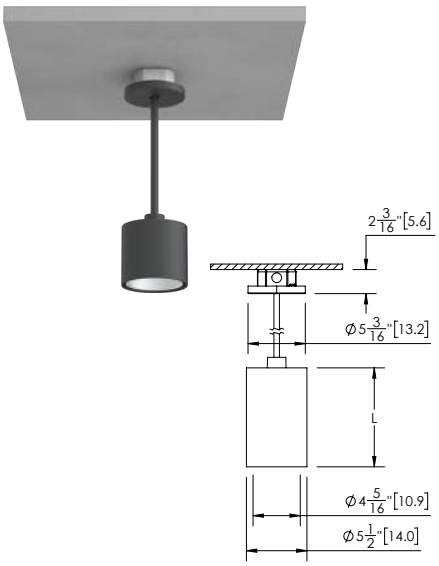
- Dimensions in inches [centimeters]
- Rigid Stems are Ø½" made of 2ft and 4ft field cuttable sections with no threading required, orderable from 2ft (S2) up to 20ft (S20).
- Powered Mounting Cords are Ø5/16" field cuttable down to 4" and include integrated Aircraft Cable (patent pending) for mechanical support without visible cable, orderable from 10ft (C120) up to 20ft (C240).
- J-boxes available by others (see Compatibility Table).

CYLINDER LENGTH (L)	DIMENSIONS INCHES (CM)
L5	5" (12.7)
L9	9" [22.9]
L14	13-5/8" [34.6]
L16	16" [40.6]

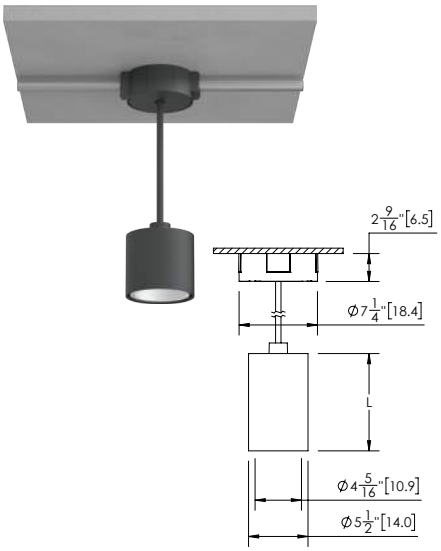
Canopy with Recessed J-box (JBX)



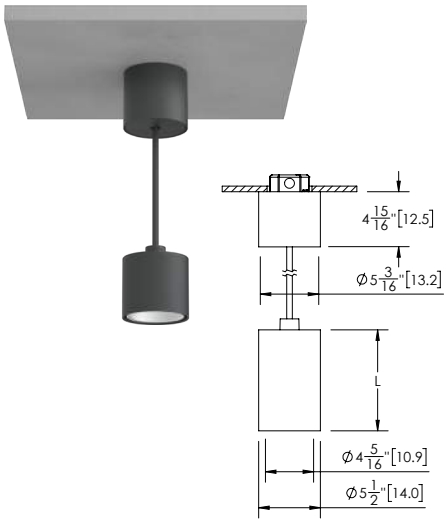
Canopy with Surface J-box (JBX)



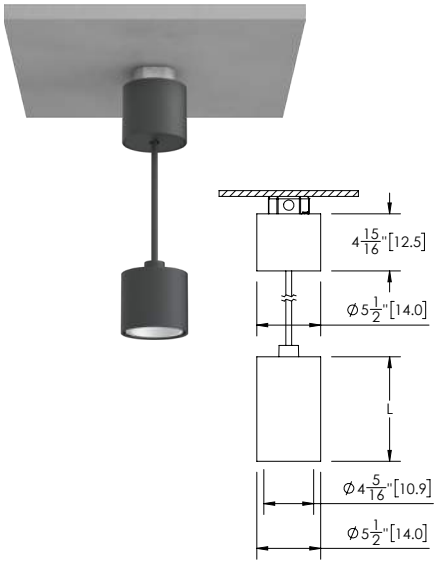
Conduit Cover Canopy with Surface J-box (JBXCC)



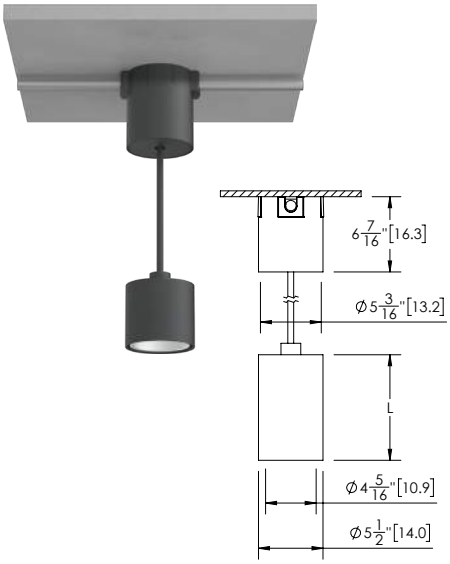
Surface Gear Box with Recessed J-box (SGB)



Surface Gear Box with Surface J-box (SGB)



Conduit Cover Surface Gear Box with Surface J-Box (SGBCC)



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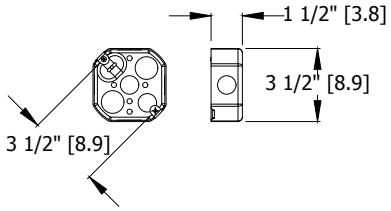
JUNCTION BOX AND CANOPY

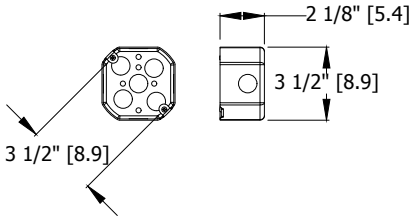
Junction Box and Canopy Details

- Dimensions in inches [centimeters]
- Options shown are available for Rigid Stem Mount or Powered Mounting Cord.
- J-boxes available by others.

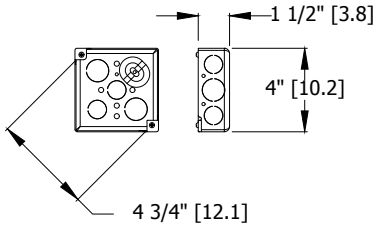
4" Octagonal j-box, 1-½" deep



4" Octagonal j-box, 2-1/8" deep

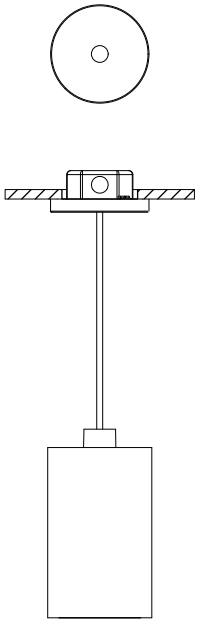


4" Square j-box, 1-½" deep

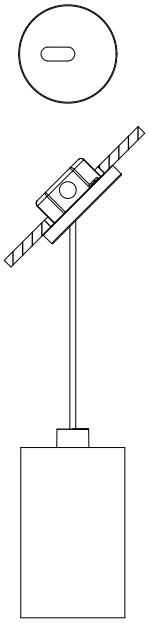


J-box Compatibility Matrix		Cylinder Configurations	
		JBX	JBXCC
Recommended J-box (by others)	4" Octagonal 4x4x1.5 deep	✓	✓
	4" Octagonal 4x4x2.125 deep	✓	✗
	4" Square 4x4x1.5 deep	✓ *with adaptor plate accessory	✗

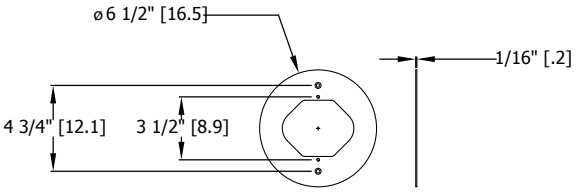
Standard Canopy (CAN) with 5° hang straight swivel



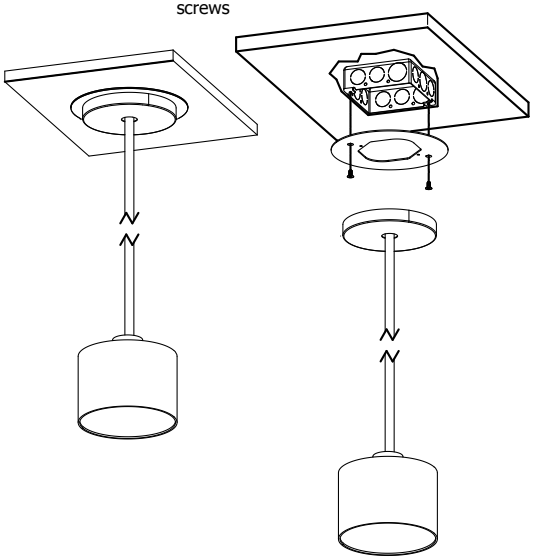
Canopy with Slot (CAN45) with 45° hang straight swivel



Cylinder Adaptor Plate (CYLJBOXADPT 4SQ20CT)



Includes 2 mounting screws



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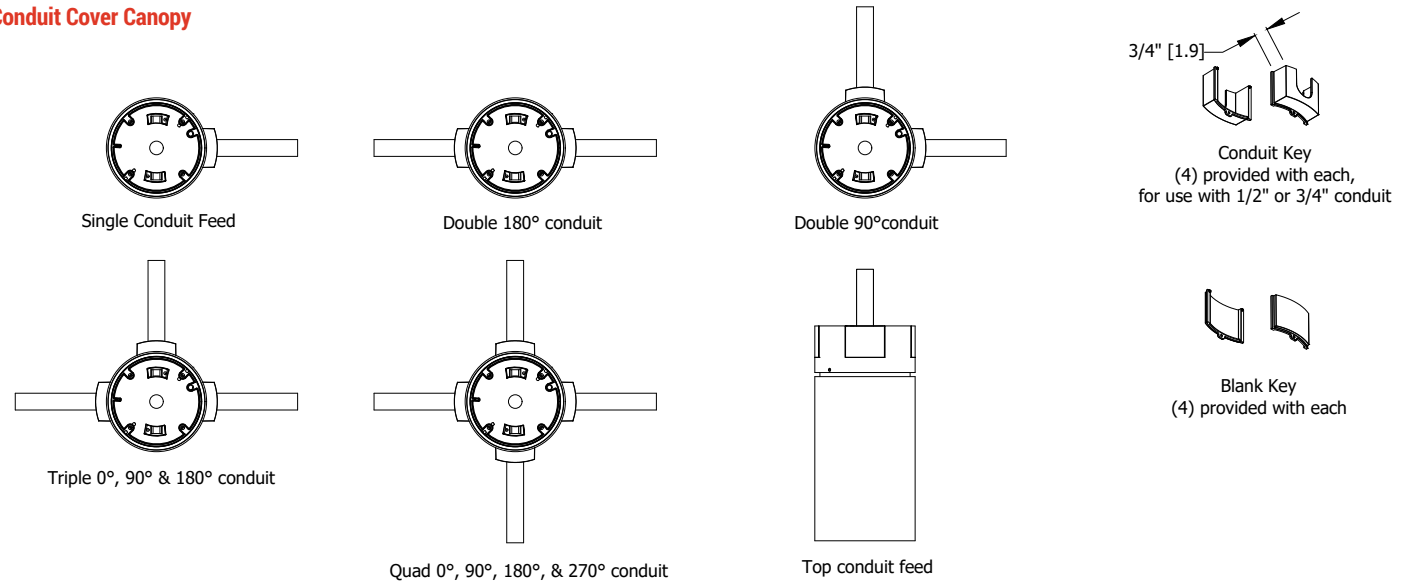
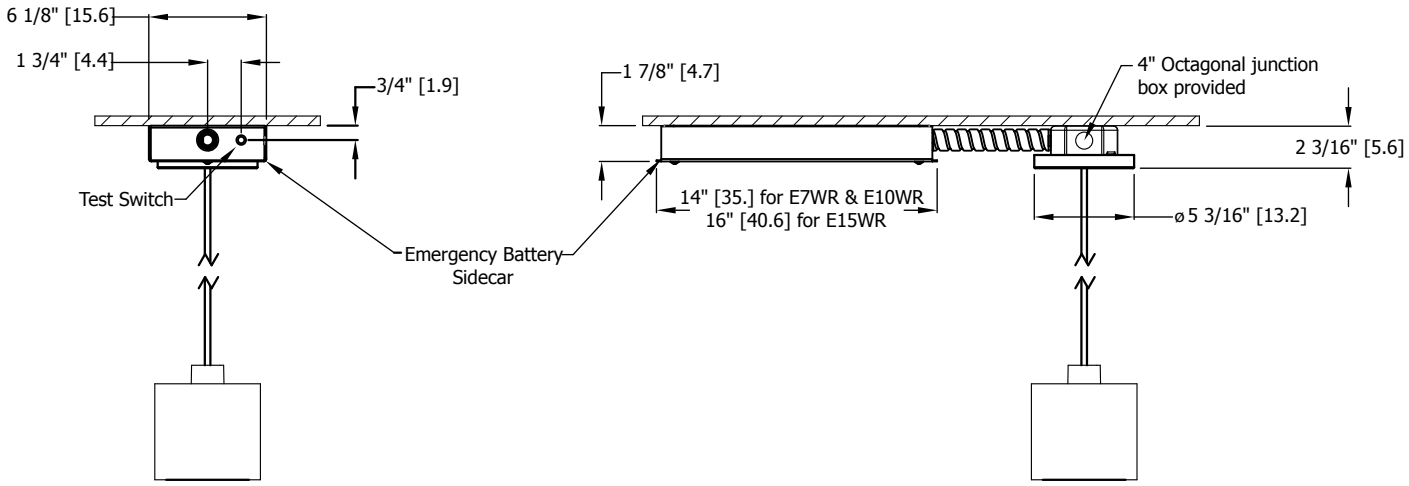
Conduit Covers and Emergency Battery Sidecar

- Dimensions in inches [centimeters]
- Options shown are available for Rigid Stem Mount or Powered Mounting Cord.
- J-boxes available by others.

Conduit Cover Canopy



Emergency Battery Sidecar Enclosure



How to Estimate Delivered Lumens in Emergency Mode

Delivered Lumens = 1.25 x P x LPW

P = Output Power/Wattage of Emergency Battery Driver (E7WR* = 7W, E10WR* = 10W, E15WR* = 15W)

LPW = Lumen per Watt rating of luminaire based on Ordering Code selections

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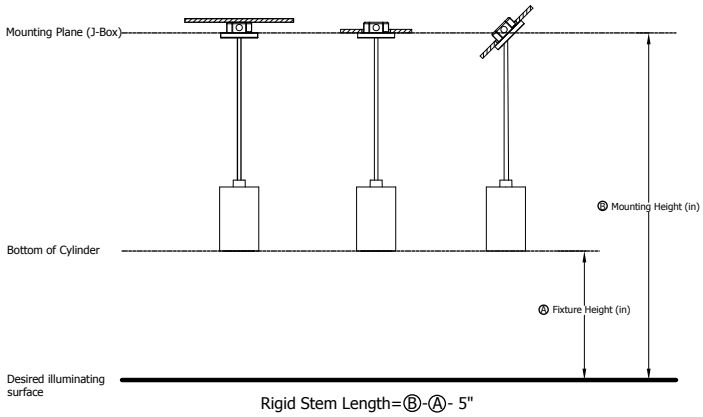
MOUNTING HEIGHT FORMULAS

Mounting Height Calculations for Field Cuttable Pendants

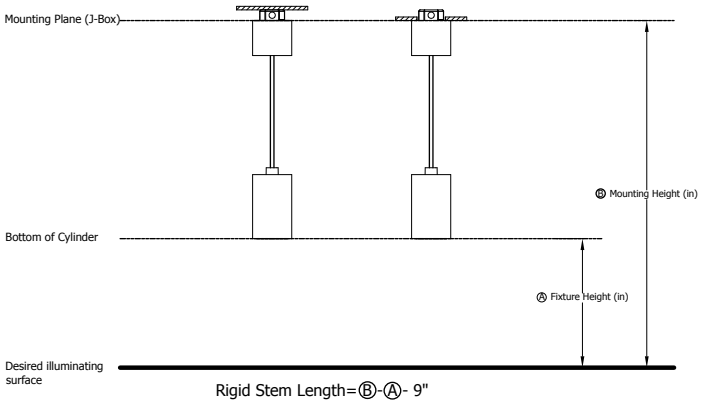
- Dimensions in inches [centimeters]
- J-boxes available by others.

Formulas for JBX/JBXCC



Rigid Stem Length=Ⓑ-Ⓐ- 5"
Mounting Cord Length=Ⓑ-Ⓐ

Formulas for SGB/SGBCC



Rigid Stem Length=Ⓑ-Ⓐ- 9"
Mounting Cord Length=Ⓑ-Ⓐ- 4"

Stabilization Kit

- Stabilization Kit (CYLSTBL KIT) offers additional support for applications where wind may be a factor and the Cylinder needs to be secured, for Rigid Stem Mount only.
- Clamping Collar consists of 2 half stem collars made of 304 grade stainless steel that clamp Rigid Stem using the socket head cap screw provided.
- 3 cables, ø1/16" x 20ft long and made of 304 grade stainless steel Aircraft Cable, support the Clamping Collar at one end and are anchored to the mounting surface at the other end (anchors by others).
- The Stabilization Kit is designed to withstand 90mph winds for 3 seconds per ASCE 7-10, MRI 50-year (fixture EPA is 0.2 sq ft).

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SPECIFICATIONS

Optical System

- Bounding Ray™ optical design delivers low brightness apertures for a comfortable lighting experience. Bounding Ray™ optical design ensures no source image up to cut-off angle, minimizing glare.
- 45° visual cut-off angle to source for L9, L14 and L16 lengths and 65° visual cut-off for L5 length per CIE 117-1995 Discomfort Glare in Interior Lighting (UGR FAQ)
- Top-Down Flash characteristics avoid flash on trim until source becomes visible.
- Batwing distributions with feathered edges to provide even illumination fixture-to-fixture. Available with 0.8, 1.0, and 1.2 spacing-to-mounting-height ratio (s/mh).
- Clean beams with soft transitions from narrow spot 10° up to wide flood 60° distributions and available every 5°.
- Optics are field changeable. However, L5 Cylinder Length optics aer not interchangeable with other Cylinder Length optics.

LED Light Engine

- Perfect Color™ consistency within 1/2-step MacAdam Ellipse using proprietary pick and place algorithm.
- 90% lumen maintenance at 55,000 hours.
- Available in 80, 90, or 95 CRI. 90 CRI has R9 greater than 50, 95 CRI has R9 greater than 80.

Trims

- Trims are field changeable via twist-lock (tool-free). However L5 Cylinder Length trims are not interchangeable with other Cylinder Lengths.
- Trims are available in 9 colors and 3 surface finishes (standard)
- Custom RAL and Paint colors available upon request.

Electrical

- 120, 277, 347, or Multi-Volt (MVOLT) 120-277 VAC input at 50/60 Hz.
- Power Factor > 85%.
- Input wires 18 AWG, 600V minimum, solid copper.

EMI/RFI

- EMI/RFI per FCC Title 47 CFR, Part 15, Class A rated standard.
- EMI/RFI per FCC Title 47 CFR, Part 15, Class B rated for Phase Dimming driver (ELV) except when used with Emergency Battery (E7WR, E10WR, E15WR) or at 15LM and above.

Controls (Optional)

- Luminaire can be equipped with interface for nLight wired, allowing it to communicate over an nLight network. nLight wired options ship with an nPS 80 EZ power pack to be mounted to a plenum j-box through (via 1/2" knockout) and connected to the Fixture control wires. Couple with nLight-enabled sensors, power packs, or WallPods using CAT-5 cabling to create an nLight Control Zone. Link Control Zone to a Gateway directly or via a Bridge for remote status monitoring and control using SensorView software.
- Luminaire can be equipped with interface for nLight Air, allowing it to communicate over the wireless nLight control platform. nLight Air options ship with an rPP20 power pack to be mounted to a plenum j-box through (via 1/2" knockout) and connected to the Fixture control wires. Can be paired to other luminaires and wall switches through CLAIRITY+, a mobile app, which allows individual fixture control.

Dimming

- Luminaire Is capable of continuous dimming without perceivable flicker (stroboscopic) as measured by flicker index (ASNI/IES RP-16-10).
- Available dimming ranges include: 100%-10% (MIN10), 100%-1% (MIN1), and 100%-0.1% (DARK) of rated lumen output.
- Available with smooth shut off function from minimum dimming level to 0%.
- EldoLED drivers (EZT, DALI) conform to IEEE P1789 standards.
- Drivers are inaudible in 24dB environment and stable even when input voltage conditions experience typical commercial environment fluctuations.

Emergency Battery (Optional)

- Luminaires equipped with battery pack (E7WR, E10WR, E15WR) comply with NFPA 101 (Life Safety Code) and deliver constant light output for a duration of 90 minutes minimum with AC power loss.
- Emergency battery is mounted to ceiling via remote enclosure (sidecar).
- Emergency battery is CEC T20 compliant.

Installation

- Rigid Stems are field cuttable with no threading required.
- Rigid Stem lengths consist of 2ft and 4ft sections.
- Powered Mounting Cords are field cuttable down to 4" and include integrated Aircraft Cable (patent pending) for mechanical support without visible cable.
- Luminaire can be installed to 4" Octagonal j-box (1-1/2" or 2-1/8" deep depending on ordering configuration).
- Luminaire can be installed to 4" Square j-box (1-1/2" deep) when used with Cylinder Adaptor Plate (CLYLJBOXADPT 4SQ20CT).
- Optional, field configurable Conduit Covers are available and match Cylinder finish and diameter.

Construction

- Heavy-gauge extruded Aluminum construction.
- Reflector design allows air flow across heatsink to improve thermal management.
- Light Engine and Driver are field replaceable and serviceable from below the ceiling.

Listings

- Fixtures are CSA certified to meet US and Canadian standards.
- All fixtured are manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" per UL.
- Damp Location standard.
- Wet Location available.

Photometrics

- All photometry is conducted by IESNA standard LM-79-08 in an accredited lab.
- LEDs are tested to LM-80 standards. Lumen maintenance is calculated via TM-21.

Warranty

- 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note:

- Actual performance may differ as a result of end-user environment and application.
- All values are design or typical values, measured under laboratory conditions at 25 °C.
- The product images shown are for illustration purposes only and may not be an exact representation of the product.

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TABLES OF USE

Dimming Configurations

Dimming Level		Control Input	Dimming Level	Driver Dim Curve	Recommended Control Dim Curve
MIN10	+	ZT	100% to 10%	Linear	Linear/Logarithmic
	+	EZT	100% to 10%	Linear	Linear/Logarithmic
MIN1	+	ZT	100% to 1%	Linear	Linear/Logarithmic
	+	EZT	100% to 1%	Linear	Linear/Logarithmic
	+	ELV	100% to 1%*	n/a	n/a
DARK	+	EZT	100% to 0.1%	Logarithmic	Linear
	+	DMX	100% to 0.1%	Square	Linear
	+	DALI	100% to 0.1%	Logarithmic	Linear

* ELV Minimum Dimming level depends on dimmer and dimmer load

Nlight Configurations

Dimming Level		Control Input	Dimming Level	Control Provided	Driver Provided
MIN10	+	NLIGHT	100% to 10%	NPS 80 EZ	eldoLED 0-10V ECOdrive
	+	NLIGHTER	100% to 10%	NPS 80 EZ ER	eldoLED 0-10V ECOdrive
	+	NLTAIR2	100% to 10%	RPP20	eldoLED 0-10V ECOdrive
	+	NLTAIREM2	100% to 10%	RPP20 EM	eldoLED 0-10V ECOdrive
MIN1	+	NLIGHT	100% to 1%	NPS 80 EZ	eldoLED 0-10V ECOdrive
	+	NLIGHTER	100% to 1%	NPS 80 EZ ER	eldoLED 0-10V ECOdrive
	+	NLTAIR2	100% to 1%	RPP20	eldoLED 0-10V ECOdrive
	+	NLTAIREM2	100% to 1%	RPP20 EM	eldoLED 0-10V ECOdrive
DARK	+	NLIGHT	100% to 0.1%	NPS 80 EZ	eldoLED 0-10V SOLOdrive
	+	NLIGHTER	100% to 0.1%	NPS 80 EZ ER	eldoLED 0-10V SOLOdrive
	+	NLTAIR2	100% to 0.1%	RPP20	eldoLED 0-10V SOLOdrive
	+	NLTAIREM2	100% to 0.1%	RPP20 EM	eldoLED 0-10V SOLOdrive

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provided consistent color appearance and out-of-the-box control capability with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about A+, visit www.acuitybrands.com/aplus.

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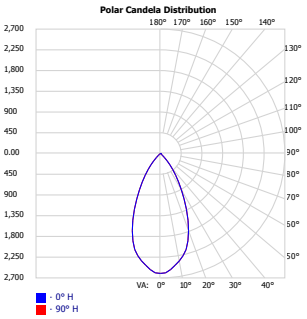
PHOTOMETRY

MD Medium Beam

IVO4CYL PC D 20LM 35K 80CRI MD L9/L14/L16 P AR LSS

Wattage: 20.5, Lumens: 1920, LPW: 94, S/MH: ..8, Test No: 24-850-22P3302



Candela Summary	
0°	2603
10°	2366
20°	1784
30°	909
40°	319
50°	26
60°	6
70°	3
80°	1
90°	0

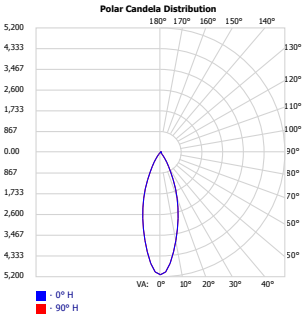
Zonal Lumen Summary		
Zone	Lumens	%
0-30	1435	74.7%
0-40	1798.4	93.7%
0-60	1914	99.7%
0-90	1920.1	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	40.67	7.6	7.6
10'	26.03	9.5	9.5
12'	18.07	11.4	11.4
14'	13.28	13.3	13.3
16'	10.17	15.2	15.2

35 Degree Beam

IVO4CYL PC D 20LM 35K 80CRI 35D L9/L14/L16 P AR LSS

Wattage: 20.5, Lumens: 2044.6, LPW: 100, S/MH: .54, Test No: 24-850-34P1217



Candela Summary	
0°	5116
10°	3734
20°	2039
30°	675
40°	120
50°	14
60°	4
70°	2
80°	1
90°	0

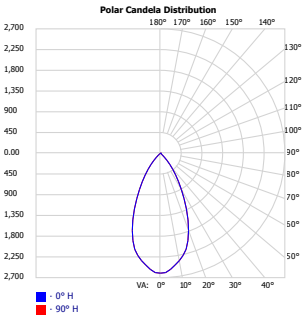
Zonal Lumen Summary		
Zone	Lumens	%
0-30	1778.1	87.0%
0-40	1992.7	97.5%
0-60	2040.2	99.8%
0-90	2044.6	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	79.94	4.8	4.8
10'	51.16	6	6
12'	35.53	7.2	7.2
14'	26.1	8.4	8.4
16'	19.99	9.6	9.6

50 Degree Beam

IVO4CYL PC D 20LM 35K 80CRI 50D L9/L14/L16 P AR LSS

Wattage: 20.5, Lumens: 1920.1, LPW: 94, S/MH: .8, Test No: 24-850-22P3310



Candela Summary	
0°	2603
10°	2366
20°	1784
30°	909
40°	319
50°	26
60°	6
70°	3
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1435	74.7%
0-40	1798.4	93.7%
0-60	1914	99.7%
0-90	1920.1	100.0%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	40.67	7.6	7.6
10'	26.03	9.5	9.5
12'	18.07	11.4	11.4
14'	13.28	13.3	13.3
16'	10.17	15.2	15.2

CRI/CCT Multiplier Table		
CRI	CCT	Multiplier
80	2700K	0.92
	3000K	0.96
	3500K	1.00
	4000K	1.01
	5000K	1.04
90	2700K	0.80
	3000K	0.85
	3500K	0.85
	4000K	0.89
95	2700K	0.68
	3000K	0.75

Reflector Finish Multiplier		
Trim Color	Optical Finish	Multiplier
AR	LSS	1.00
AR	LS	1.06
AR	LD	0.97
GR	LSS	0.97
GR	LS	0.98
GR	LD	0.92
PR	LSS	0.97
PR	LS	0.97
PR	LD	0.90
BR	LSS	0.68
BR	LS	0.68
BR	LD	0.68
WTR	LSS	0.87
WTR	LS	0.89
WTR	LD	0.87
WR		1.03
WMR		1.03
WRAMF		1.04
BZR		0.68

UGR (70% 50% 20% reflectance using a 4H x 8H room size)						
Lumen Package	Crosswise			Endwise		
	MD	MWD	WD	MD	MWD	WD
05LM	7.9	4.9	4.9	7.9	4.9	4.9
07LM	9.2	6.2	6.2	9.2	6.2	6.2
10LM	10.3	7.3	7.3	10.3	7.3	7.3
15LM	11.4	8.4	8.4	11.4	8.4	8.4
20LM	12.3	9.4	9.3	12.3	9.4	9.3
25LM	13	10.1	10.1	13	10.1	10.1
30LM	13.6	10.6	10.6	13.6	10.6	10.6

*UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.

**Calculated using an AR (Clear reflector) with LSS (Semi-Specular) finish

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PHOTOMETRY

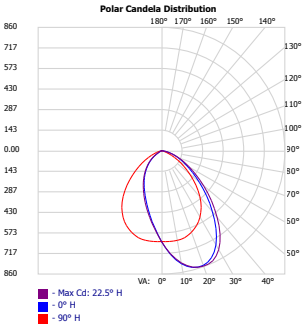
Superior Perfomance*

Nominal Lumens	05LM	07LM	10LM	15LM	20LM	25LM	30LM	35LM	40LM	45LM
Delivered Lumens	340	507	683	1025	1357	1687	1884	2285	2618	2921
Wattage	5.1	7.3	9.8	15.0	20.5	26.8	29.7	34.4	41.8	45.3
Lumens per Watt	66	69	69	69	66	63	63	66	63	64

*Based on Lensed Wall Wash performance: 3500K 80CRI MD P AR LSS, for L9, L14, and L16. See IES files available online for L5 performance.

LW Lensed Wall Wash

IVO4CYL PC WW 20LM 35K 80CRI L9/L14/L16 LW AR LSS **Wattage: 20.5, Lumens: 1357.4, LPW:66, S/MH: 1.5, Test No: 24-824-1P224**



Candela Summary	
0°	633
10°	800
20°	851
30°	759
40°	550
50°	346
60°	199
70°	101
80°	32
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	503.8	37.1%
0-40	804.4	59.3%
0-60	1238.8	91.3%
0-90	1357.4	100.0%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	9.9	16.1	9.1
10'	6.33	20.1	11.4
12'	4.4	24.1	13.6
14'	3.23	28.1	15.9
16'	2.47	32.1	18.2

CRI/CCT Multiplier Table		
CRI	CCT	Multiplier
80	2700K	0.92
	3000K	0.96
	3500K	1.00
	4000K	1.01
	5000K	1.04
90	2700K	0.80
	3000K	0.85
	3500K	0.85
	4000K	0.89
95	2700K	0.68
	3000K	0.75

Reflector Finish Multiplier		
Trim Color	Optical Finish	Multiplier
AR	LSS	1.00
AR	LS	1.06
AR	LD	0.97
GR	LSS	0.97
GR	LS	0.98
GR	LD	0.92
PR	LSS	0.97
PR	LS	0.97
PR	LD	0.90
BR	LSS	0.68
BR	LS	0.68
BR	LD	0.68
WTR	LSS	0.87
WTR	LS	0.89
WTR	LD	0.87
WR		1.03
WMR		1.03
WRAMF		1.04
BZR		0.68

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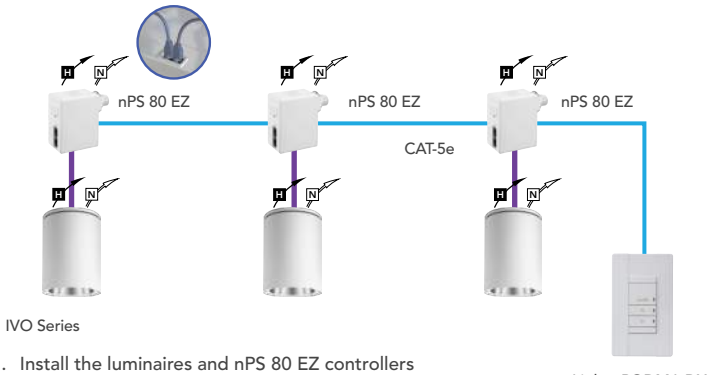
NLIGHT

Single Lighting Controls Platform for Indoor & Outdoor Spaces

nLight® is your networked lighting controls platform, for indoor and outdoor applications, providing wired or wireless options. Scaling from room to campus-wide applications, it is the one platform that grows with your business today and tomorrow; to seamlessly address energy cost optimization, building code compliance, improved occupant comfort, and much more. nLight also interfaces with DALI®, BACnet®, DMX and additional third-party devices.

nLightcontrols.com

Wired Controls



1. Install the luminaires and nPS 80 EZ controllers and make the low-voltage connections
2. Install the nLight Wired wall switch
3. Connect the nLight devices using standard CAT-5e cables and the controls devices will automatically discover each other and work (plug and play)

Wireless Controls

1. Install the luminaires and rPP20 power/relay packs
2. Install the nLight AIR battery-powered wall switch
3. Use CLAIRITY™+ mobile app to pair the luminaires with the wall switch and if desired, customize the device settings

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

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Type: _____

Project: _____

ILLUMINA®

TITLE 20 TITLE 24 IK07 IP66 NSF BAA DLC LISTED PREMIUM DLC LISTED UL CERTIFIED

BS100LED

- The **ILLUMINA®** BS100LED is corrosion, flame and vandal resistant.
- **HOUSING:** 100% UV stabilized polycarbonate, liquid silicone perimeter gasket with memory retention.
- **DIFFUSER:** Frosted UV stabilized polycarbonate diffuser, for even light distribution and color stabilization.
- **LUMEN:**

2 FT	4 FT
LO: 30W @ 3876 to 4635 lm	VLO: 30W @ 4375 to 5208 lm
MO: 40W @ 5176 to 6172 lm	LO: 40W @ 5555 to 6627 lm
HO*: 50W @ 6464 to 7716 lm	MO: 50W @ 6944 to 8284 lm
* 3000K qualifies for DLC std	HO: 60W @ 8318 to 9946 lm
	VHO: 70W 9714 to 11,589 lm

- **OPERATING TEMP:** HT (AC Only) -40°F to 104°F (-40°C to 40°C)
  SA (AC & Emergency) 32°F to 104°F (0°C to 40°C)
- **POWER FACTOR:** Power Factor > 0.95
- **TOTAL HARMONIC DISTORTION (THD):** < 20%
- **WEIGHT:** 2 FT: 5 lbs (2.3 kg) / 4FT: 10 lbs (4.5 kg)

APPLICATION: The **BS100LED** is ideal for various commercial applications including retail, industrial, parking garages, carpot, parking structures, warehouses, breezeways, canopies, schools, and much more. It can be installed both indoor and outdoor.

ORDERING INFORMATION

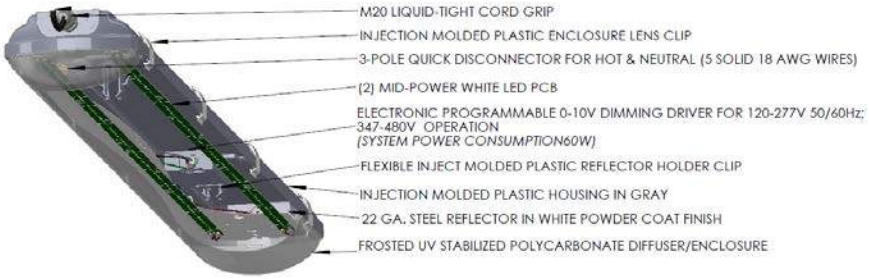
Example: BS100LED4 HT HO WT40 120-277V FSP221

MODEL	LENGTH	OPERATION	OUTPUT	COLOR TEMP	INPUT	MOUNTING	OPTIONS	
BS100LED	2 (ft)	HT (AC only)	VLO[1]	WT30 (3000K)	120-277V	blank (surface mount standard)	BLK[4] (black housing, 4't only)	OS[8,9] (external occupancy sensor)
	4[1] (ft)	SA[2] (AC & EM)	LO	WT35 (3500K)	347-480V		CRD[5] (black, 18AWG)	NOD[9] (integrated node)
			MO	WT40 (4000K)		JM[3] (j-box mount)	D (dali 2)	SP (surge protection - 10KA)
			HO	WT50 (5000K)			FA[6] (fully assembled)	SS (stainless steel clips)
			VHO[1]				FP (fuse protection - 3A)	TPS (tamper proof screws)
							IS[7,9] (internal occ sensor)	

CONTROLS & ACCESSORIES		
1PKxWBS02[11,12] (single pendant kit, 2' fixture, white, x=length)	2CH48[12] (48" chain hang kit, field cuttable)	QMBWBS04[14] (IP66 quick mount bracket, 4' fixture)
1PKxWBS04[11,12] (single pendant kit, 4' fixture, white, x=length)	EMDCB[9] (BT wireless motion and lux sensor)	RLY[9] (wireless relay
1SPKxWBS02[11,12] (swivel single pendant kit, 2' fixture, white, x=length)	HHRFSIR[10] (handheld remote for FSP221)	SW1[9] (single BT wireless switch)
1SPKxWBS04[11,12] (swivel single pendant kit, 4' fixture, white, x=length)	MLM1[9] (wireless motion and lux sensor	TM22BS04[12] (22" trunnion mount, 4' fixture)
2PKxW[11,12] (double pendant kit, white, x=length)	MM[13] (magnet mount)	
2SPKxW[11,12] (swivel double pendant kit, white, x=length)	PM (pivot mount)	
2ACx[12] (adjustable aircraft cable, x=length: 50=50", 72=72")	QMBWBS02[14] (IP66 quick mount bracket, 2' fixture)	

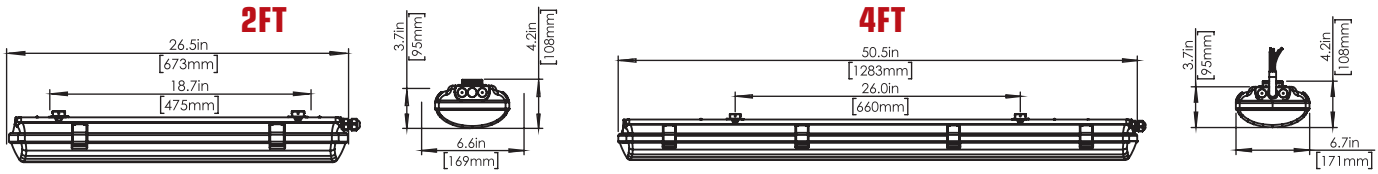
NOTE 1: VLO and VHO outputs available for 4ft only
NOTE 2: Title 20 emergency pack; 120/277V; 2FT: 7W/1022 lm; 4FT: 10W/1573 lm
NOTE 3: JM: direct j-box mount maintains fixture IP66 rating
NOTE 4: Contact factory for lead time
NOTE 5: Specify length for CRD, specify 3 or 5-conductor
NOTE 6: Includes latches, grommets, etc. installed at the factory for quick installation
NOTE 7: IS is std Beghelli sensor; FSP221, Magnum ISM1 and other sensors also available
NOTE 8: OS is std Beghelli sensor (Magnum OSM1, CRMB9, OSFSP221, SBOR and other sensors also available)
NOTE 9: Beghelli offers wireless and powerless control solutions, contact factory for more details
NOTE 10: FSP221 and OSFSP221 require HHRFSIR handheld remote accessory
NOTE 11: Standard pendant lengths "x" = 12 (12"), 24 (24") and 48 (48")
NOTE 12: Consult factory for non-standard lengths
NOTE 13: Magnetic mounts must be installed to steel beam measuring minimum 3/16" thick
NOTE 14: Quick Mount bracket requires JM mount; FA option recommended for maximum labor savings
NOTE: Red or green LED is available for horticultural applications

TECHNICAL INFORMATION



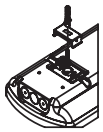
Beghelli reserves the right to change, without notice, specifications or materials that in our opinion will not alter the function or performance of the product. Technical specifications that appear on www.beghelliusa.com supersede all other versions existing in print or electronic form.

DIMENSIONS



MOUNTING OPTIONS & ACCESSORIES

Surface Mount (standard)



Aviation Cable Kit

(2AC50, 2AC72)

Chain Hang Kit

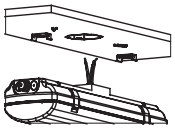
(2CH48)

Double Pendant Kit

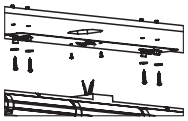
(2PK12W, 2PK24W, 2PK48W)

J-Box & Quick Mount Bracket Mount

(JM)



J-box mount
(wet location)



Quick mount bracket
(wet location)

Magnet Mount Kit

MM

Pivot Mount Kit

PM

Single Pendant Kit

(1PKxWBS04, x=12", 24", 48")

Swivel Double Pendant Kit

(2SPK12W, 2SPK24W, 2SPK48W)

Swivel Single Pendant Kit

(1SPKxWBS04, x=12", 24", 48")

Trunnion Mount Kit

(TM22BS04)

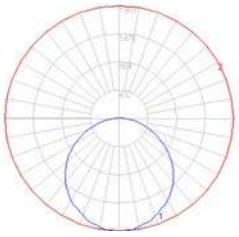
22" std size

NOTE: When wall mounted, DAMP LOCATION LISTED

PHOTOMETRICS

BS100LED2HTMOWT40120-277V

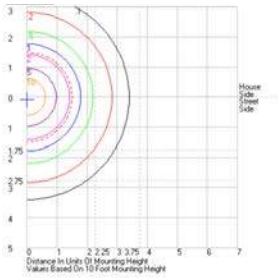
POLAR CURVES



Characteristics
Electronic driver
LED 4000°K

Lumens Per Lamp	N.A. (absolute)
Total Lamp Lumens	N.A. (absolute)
Luminaire Lumens	5835
Total Luminaire Efficiency	N.A.
Luminaire Efficacy Rating (LER)	146
Total Luminaire Watts	40
Ballast Factor	1.00
CIE Type	Direct

ISOLINES



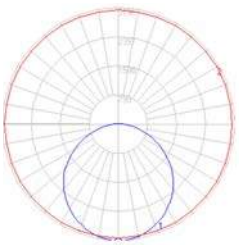
Zonal Lumen Summary

Zone	Lumens	%Lamp	%Fixt
0-20	714.94	N.A.	12.30
0-30	1514.49	N.A.	26.00
0-40	2483.26	N.A.	42.60
0-60	4406.18	N.A.	75.50
0-80	5537.8	N.A.	94.90
0-90	5727.7	N.A.	98.20
10-90	5541.68	N.A.	95.00
20-40	1768.32	N.A.	30.30
20-50	2779.08	N.A.	47.60
40-70	2624.87	N.A.	45.00
60-80	1131.62	N.A.	19.40
70-80	429.67	N.A.	7.40
80-90	189.90	N.A.	3.30
90-110	90.62	N.A.	1.60
90-120	101.63	N.A.	1.70
90-130	105.73	N.A.	1.80
90-150	106.88	N.A.	1.80
90-180	107.28	N.A.	1.80
110-180	16.66	N.A.	0.30
0-180	5834.98	N.A.	100.00

Total Luminaire Efficiency = N.A.%

BS100LED4HTHOWT40120-277V

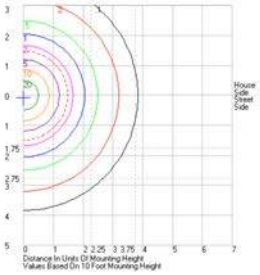
POLAR CURVES



Characteristics
Electronic driver
LED 4000°K

Lumens Per Lamp	N.A. (absolute)
Total Lamp Lumens	N.A. (absolute)
Luminaire Lumens	9400
Total Luminaire Efficiency	N.A.
Luminaire Efficacy Rating (LER)	157
Total Luminaire Watts	60
Ballast Factor	1.00
CIE Type	Direct

ISOLINES



Zonal Lumen Summary

Zone	Lumens	%Lamp	%Fixt
0-20	1166.13	N.A.	12.40
0-30	2470.92	N.A.	26.30
0-40	4047.23	N.A.	43.10
0-60	7164.41	N.A.	76.20
0-80	8962.46	N.A.	95.30
0-90	9253.89	N.A.	98.40
10-90	8951.18	N.A.	95.20
20-40	2881.1	N.A.	30.60
20-50	4525.25	N.A.	48.10
40-70	4236.8	N.A.	45.10
60-80	1798.04	N.A.	19.10
70-80	678.43	N.A.	7.20
80-90	291.43	N.A.	3.10
90-110	129.39	N.A.	1.40
90-120	142.18	N.A.	1.50
90-130	145.78	N.A.	1.60
90-150	146.24	N.A.	1.60
90-180	146.24	N.A.	1.60
110-180	16.86	N.A.	0.20
0-180	9400.13	N.A.	100.00

Total Luminaire Efficiency = N.A.%

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ILLUMINA® BS100LED

ENERGY CHART

BS100LED-2HT-LO-WT35-120-277V 2 ft 138 lm/W 30 4130

MODEL	LENGTH	EFFICACY	CONSUMPTION WATTAGE	LUMEN OUTPUT	CRI	L70 (HRS) TESTED	L70 (HRS) PROJECTED
2FT							
BS100LED 2HT LO WT30 120-277V	2 ft	129 lm/W	30	3876	>80	>60,000	>100,000
BS100LED-2HT LO WT35 120-277V	2 ft	138 lm/W	30	4130	>80	>60,000	>100,000
BS100LED 2HT LO WT40 120-277V	2 ft	146 lm/W	30	4381	>80	>60,000	>100,000
BS100LED 2HT LO WT50 120-277V	2 ft	155 lm/W	30	4635	>80	>60,000	>100,000
BS100LED 2HT MO WT30 120-277V	2 ft	129 lm/W	40	5176	>80	>60,000	>100,000
BS100LED 2HT MO WT35 120-277V	2 ft	138 lm/W	40	5503	>80	>60,000	>100,000
BS100LED 2HT MO WT40 120-277V	2 ft	146 lm/W	40	5835	>80	>60,000	>100,000
BS100LED 2HT MO WT50 120-277V	2 ft	154 lm/W	40	6172	>80	>60,000	>100,000
BS100LED 2HT HO WT30 120-277V	2 ft	129 lm/W	50	6464	>80	>60,000	>100,000
BS100LED 2HT HO WT35 120-277V	2 ft	138 lm/W	50	6881	>80	>60,000	>100,000
BS100LED 2HT HO WT40 120-277V	2 ft	146 lm/W	50	7301	>80	>60,000	>100,000
BS100LED 2HT HO WT50 120-277V	2 ft	154 lm/W	50	7716	>80	>60,000	>100,000
4FT							
BS100LED 4HT VLO WT30 120-277V	4 ft	146 lm/W	30	4375	>80	>60,000	>100,000
BS100LED 4HT VLO WT35 120-277V	4 ft	155 lm/W	30	4648	>80	>60,000	>100,000
BS100LED 4HT VLO WT40 120-277V	4 ft	165 lm/W	30	4937	>80	>60,000	>100,000
BS100LED 4HT VLO WT50 120-277V	4 ft	174 lm/W	30	5208	>80	>60,000	>100,000
BS100LED 4HT LO WT30 120-277V	4 ft	139 lm/W	40	5555	>80	>60,000	>100,000
BS100LED 4HT LO WT35 120-277V	4 ft	148 lm/W	40	5901	>80	>60,000	>100,000
BS100LED 4HT LO WT40 120-277V	4 ft	157 lm/W	40	6264	>80	>60,000	>100,000
BS100LED 4HT LO WT50 120-277V	4 ft	166 lm/W	40	6627	>80	>60,000	>100,000
BS100LED 4HT MO WT30 120-277V	4 ft	139 lm/W	50	6944	>80	>60,000	>100,000
BS100LED 4HT MO WT35 120-277V	4 ft	148 lm/W	50	7379	>80	>60,000	>100,000
BS100LED 4HT MO WT40 120-277V	4 ft	157 lm/W	50	7831	>80	>60,000	>100,000
BS100LED 4HT MO WT50 120-277V	4 ft	166 lm/W	50	8284	>80	>60,000	>100,000
BS100LED 4HT HO WT30 120-277V	4 ft	139 lm/W	60	8318	>80	>60,000	>100,000
BS100LED 4HT HO WT35 120-277V	4 ft	148 lm/W	60	8861	>80	>60,000	>100,000
BS100LED 4HT HO WT40 120-277V	4 ft	157 lm/W	60	9400	>80	>60,000	>100,000
BS100LED 4HT HO WT50-120-277V	4 ft	166 lm/W	60	9946	>80	>60,000	>100,000
BS100LED 4HT VHO WT30 120-277V	4 ft	139 lm/W	70	9714	>80	>60,000	>100,000
BS100LED 4HT VHO WT35 120-277V	4 ft	148 lm/W	70	10343	>80	>60,000	>100,000
BS100LED 4HT HO WT40 120-277V	4 ft	157 lm/W	70	10955	>80	>60,000	>100,000
BS100LED 4HT VHO WT50 120-277V	4 ft	166 lm/W	70	11589	>80	>60,000	>100,000

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ELECTRICAL RATING

PRODUCT	NOMINAL POWER (W)	AC CURRENT (A) AC VOLTAGE 120 V	AC CURRENT (A) AC VOLTAGE 277 V	FREQUENCY (HZ)	DC VOLTAGE (V)	DC CURRENT (MA)
2FT						
BS100LED-2HT-LO	30	0.26	0.11	50/60	45	600
BS100LED-2HT-MO	40	0.34	0.15	50/60	45	800
BS100LED-2HT-HO	50	0.43	0.18	50/60	45	1000
4FT						
BS100LED-4HT-VLO	30	0.26	0.11	50/60	45	600
BS100LED-4HT-LO	40	0.34	0.15	50/60	45	800
BS100LED-4HT-MO	50	0.43	0.18	50/60	45	1000
BS100LED-4HT-HO	60	0.51	0.22	50/60	45	1200
BS100LED-4HT-VHO	70	0.59	0.26	50/60	45	1400

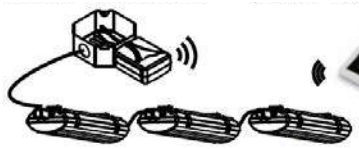
DIMMER COMPATIBILITY

DIMMER	COMPATABILITY ON/OFF	COMPATABILITY DIMMING
2FT		
LEVITON - AWRMG-7	YES	YES
LUTRON - DIVE - DVSTV	YES	YES
LUTRON - DIVE - DVTV	YES	YES
WATT STOPPER - DCLV1	YES	YES
4FT		
LEVITON - AWRMG-7	YES	YES
LUTRON - DIVE - DVSTV	YES	YES
LUTRON - DIVE - DVTV	YES	YES
WATT STOPPER - DCLV1	YES	YES

BEGHELLI LIGHTING CONTROL SOLUTIONS

DAISY CHAIN FIXTURES (RELAY)

RLY*
Wireless Relay
(Damp Location)



Max range: 100ft
Max fixtures: 20

EMDCB*
Remote Sensor
(Damp Location)

SW1*
Single Switch
(Damp Location)

EXTERNAL NODE & SENSOR (OS)

OS (Beghelli standard)
(Wet Location)

External occ sensor options:
OSM1*, SBOR, CRMB9, **OSFSP221**, etc.

SW1*
Single Switch
(Damp Location)

INTEGRATED NODE (NOD)

NOD*

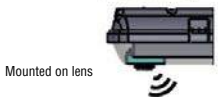
Node

EMDCB*
Remote Sensor
(Damp Location)

SW1*
Single Switch
(Damp Location)

INTEGRATED NODE & SENSOR (IS)

IS (Beghelli standard)
(Wet Location)



Internal occ sensor options:
ISM1*, FSP221, etc.

SW1*
Single Switch
(Damp Location)

* Magnum control options also available (RLYM1 relay, MLM1 sensor, SW1M1 switch, NODM1 node and ISM1 and OSM1 sensors)

❖ Beghelli offers standard wired and wireless control solutions. Beghelli fixtures are compatible with most control solutions available in the market, consult factory for more details.

WARRANTY: 5 years, see website for full warranty details

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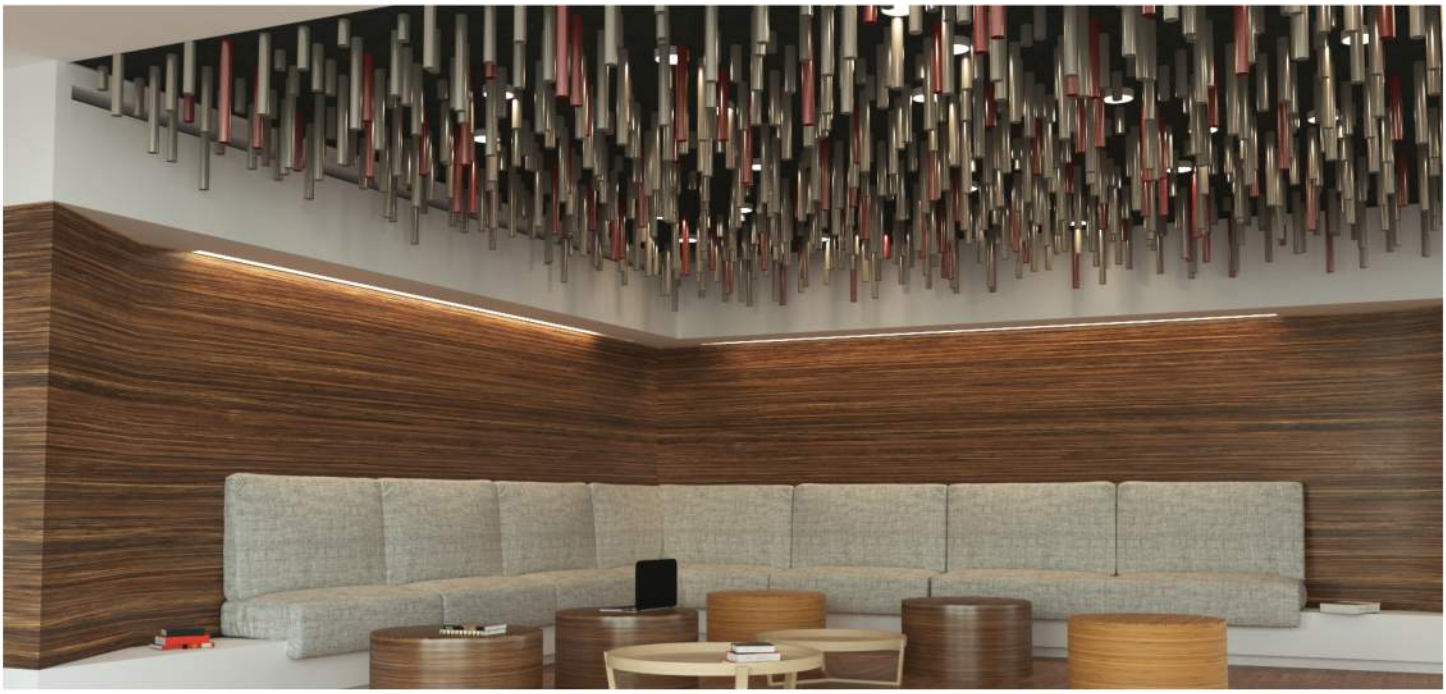
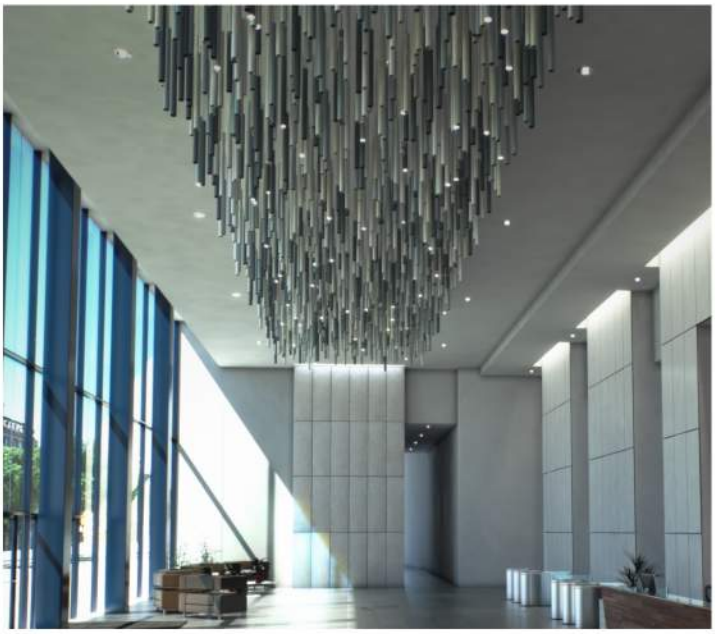
About:

Even with a minimal number of modules, you can generate huge design impact using Alluvia®. We provide options for the depth of the system components in each tile so that Alluvia® fulfills your design goal, whether you are working with a tall atrium or a low ceiling. The end product comes equipped with all the necessary attachments and mounting hardware, making installation approachable and simple. Tubes are easily removable and offer the opportunity to integrate lighting.





Preconfigured Solutions

Proven Project Managment

Functional Integration

Advanced Technology

Performance & Sustainable Practices

Easy Installation

ALLUVIA® - Forest

STANDARD CEILING SYSTEMS

+ STANDARD MODULE

Direct mount:
A/ Tube length
Min. 13 3/4"
Max. 31 3/4"

Wire hung:
A/ Tube length
29 3/4"
*Wire length varies

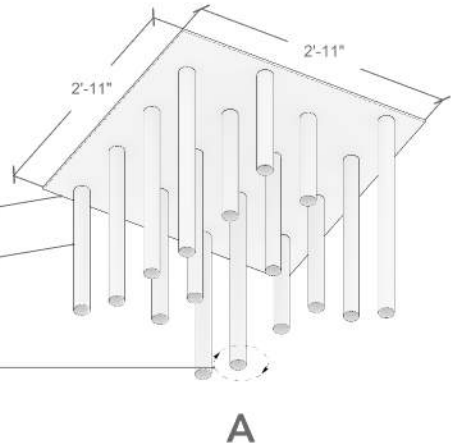
Suspended aluminum ceiling panel

2" DIA. aluminum tube

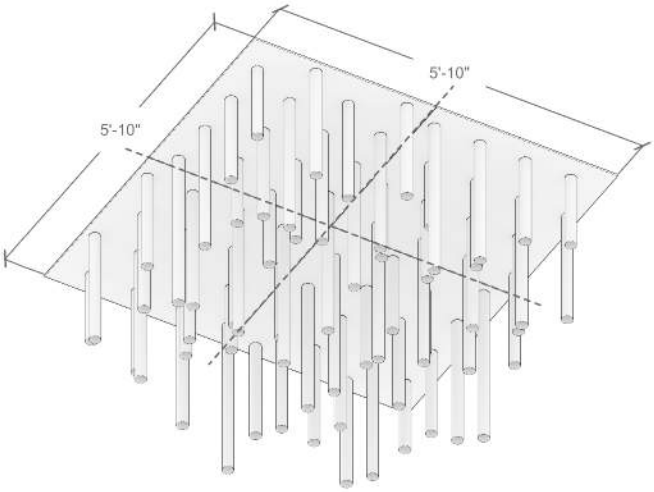
Tubes attached directly to panels, and are removable individually

24" Average tube length
12" Average tube length

*All dimensions nominal

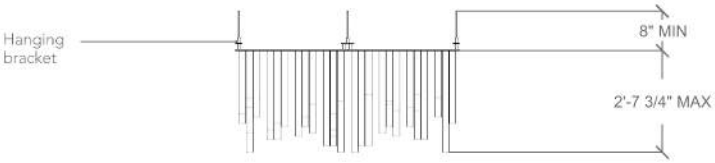


+ MODULE CONFIGURATION (2x2 GRID)

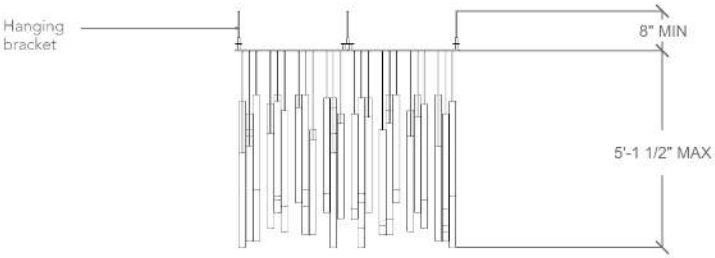


+ SECTIONAL ELEVATION

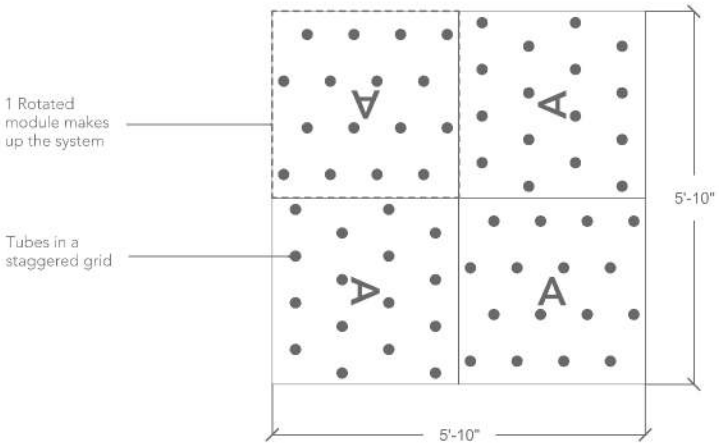
Direct Mount (24" Average)



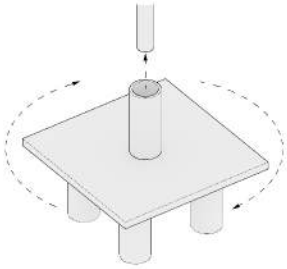
Wire Hung

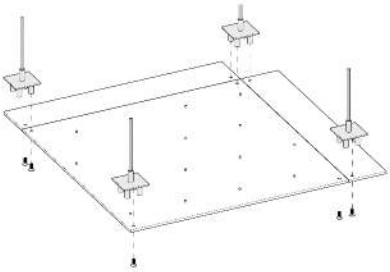


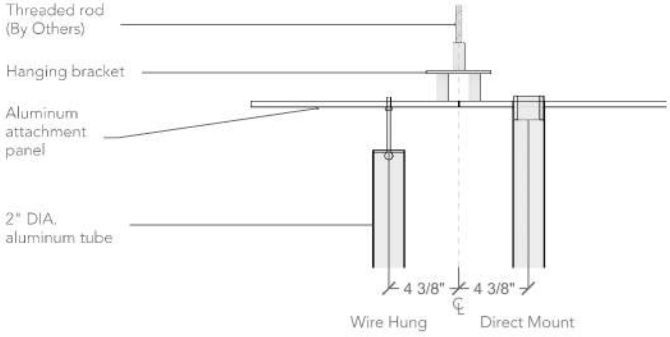
+ PLAN CONFIGURATION (ALL PANELS MUST TILE AS SHOWN)



+ ATTACHMENT DETAILS







*Patented

Coronet®
designed and built in the USA

a CarbonNeutral company

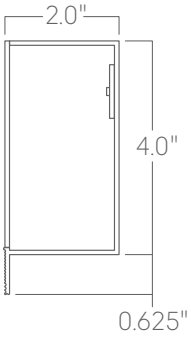
Lalina wall wash

Our Lalina luminaire is field-curvable to conform to rounded architectural coves. A ceiling-facing, precision engineered asymmetric optic provides subtle, even, indirect illumination. Nominal lengths are field-cuttable*.

Features

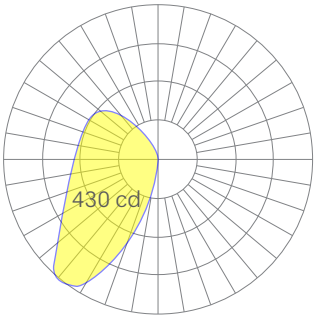
- Patent pending
- Field-curvable/cuttable* flexible housing and spackle flange
- Minimum 9 inch radius
- Specifiable outputs available
- Specifiable color temperature. CRI > 90, R9 > 50
- Integral, specifiable dimmable drivers or PoE
- 5 Year, 50,000 hour warranty, damp location rated
- WELL Building Standard compatible learn more

Dimensions

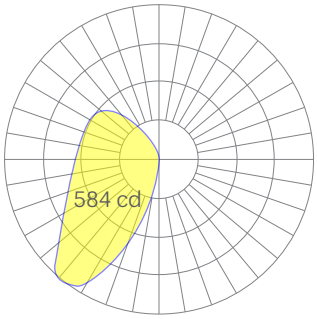


*Fixture length may be trimmed up to 3".

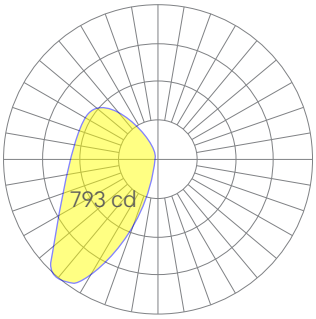
Optics



low



medium



high

Representative distribution and peak candela. For other options see order information or IES files here.

Modification date: July,2025

coronetled.com
T 973 345 7660

Coronet reserves the right to make design changes.

Lalina wall wash

Ordering Information

For each option group below specify one option. If you don't see your preferred option listed, contact us for help.

1	Fixture ID	2	Length	3	Color Temperature	4	Output
LALINA.WW.STR *(straight)* **LALINA.WW.CRV** *(curved)*		**2** **4** **8** **X'X"** **PAT**	2 ft 4 ft 8 ft Specify Length Pattern (Consult Factory)	**27** **30** **35** **40** **50**	2700K/90 CRI 3000K/90 CRI 3500K/90 CRI 4000K/90 CRI 5000K/90 CRI	**LOW** **MED** **HIGH** **CUST**	Low output Medium output High output Custom output Specify watts or lumens

5	Voltage	6	Driver	7	Finish	8	Mounting
UNV **347V**	Universal (120/277V) 347V Must use DB Driver	**DB** **DB.1%** **ELV** **TRI** **LDE** **DALI** **PoE**	Standard 0-10V 1% 0-10V 0.1% Reverse Phase 1% (120V only) For compatible dimmers see here. Forward phase (120V only) For compatible dimmers see here. Lutron Digital EcoSystem DALI-2 Driver Power over Ethernet	**W**	White	**T** **T15** **SG** **NT** **WOOD**	9/16" Tee Grid 15/16" Tee Grid Slot Grid/Interlude Mud-in Flange Wood ceiling Provide specifications.
			Linear Dimming Curve by default. Consult factory for Logarithmic options.				

9	Optics	10	Sensors/Controls	11	Circuit	12	Options
SD	Standard Diffuser	**NA** **ACM** **CCS** **AWNR** **OTHER**	None Acuity nLight Module Only Casambi Module Lutron Athena Wireless Node Module Consult Factory	**NA** **EMPCK** **EMCKT**	None Emergency battery pack Supplied in remote enclosure Emergency circuit May require additional power feeds	**NA**	None
			All controls remote.				

Performance

Output[1]	Watts/ft	Lumens/ft
Low	5	494
Medium	7	672
High	10	912

[1]Based on a typically configured 90 CRI and 3500K luminaire using one driver.
Note: Output values were calculated in Photopia and Coronet is not responsible for real output disparities.

Custom outputs available. Please consult factory.
For 4000K multiply by 1.05; for 3000K, 0.96; for 2700K, 0.92.

Technical Information

click here or scan QR code

Wiring diagrams, PoE and sensor details

Modification date: July,2025

coronetled.com
T 973 345 7660

Coronet reserves the right to make design changes.

Lalina wall wash

Drivers & Electrical

Remote drivers with 0-10V Dimming standard. Several other driver options available; see ordering information.

For remote driver box sizes, click here.

Emergency Back-Up

For fixtures three-feet or longer, a 6W emergency driver may be wired to 4ft sections. A 10W driver is also available (consult factory). Emergency circuits for use with building generators are also available.

Weight

5 lbs per foot

Optics

Extruded satin acrylic lenses provide excellent diffusion and high transmission.

PoE (Power over Ethernet)

Compatible with virtually all PoE systems including Molex Coresync, Igor, Smartengine, Platformatics, and NuLED SPICEbox.

Consult factory for systems not listed. See here for more info.

Finishes

All luminaires are finished in high quality polyester powder coating. Our standard color is white.

coronetled.com
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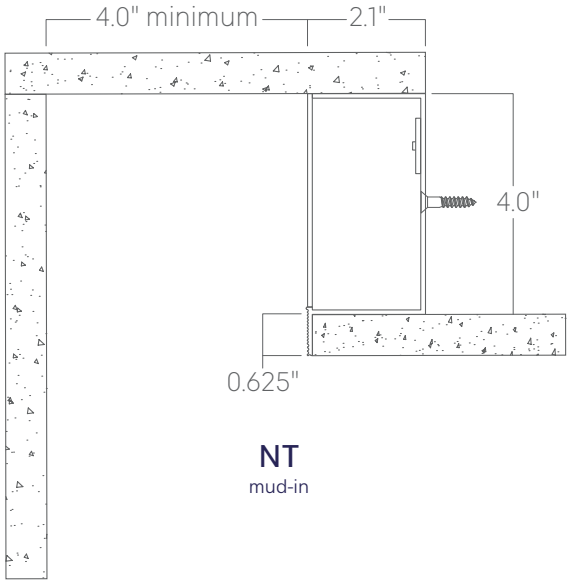
Coronet reserves the right to make design changes.

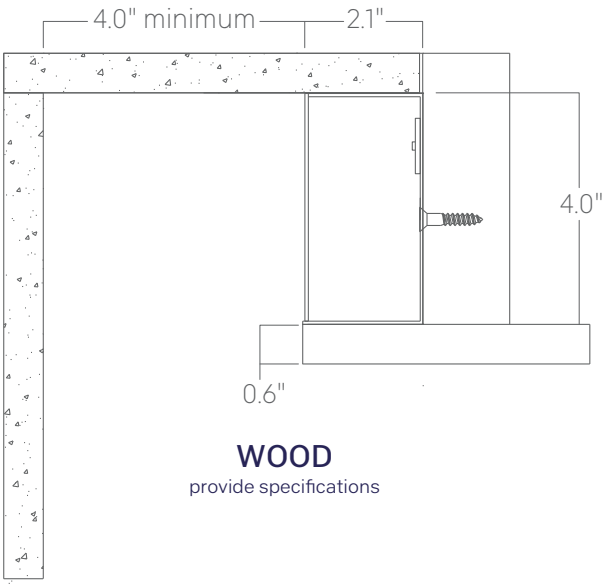
Lalina wall wash

Mounting Options

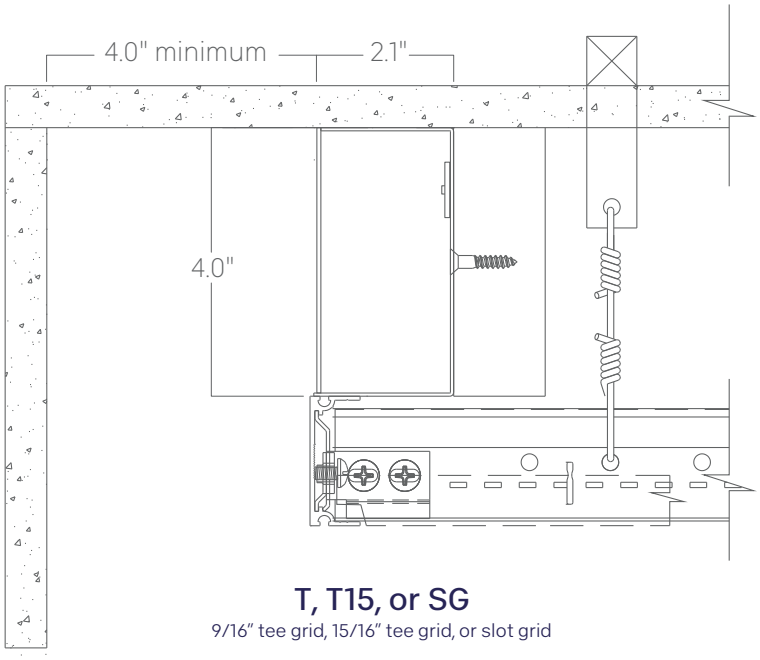
Custom mounting types and ceiling transitions available; consult factory.



NT
mud-in



WOOD
provide specifications



T, T15, or SG
9/16" tee grid, 15/16" tee grid, or slot grid

Please consult factory shop drawings for suspension points.
To prevent damage to fixtures, factory designated suspension points must not be field altered.
Do not attempt installation if you do not understand the installation instructions.

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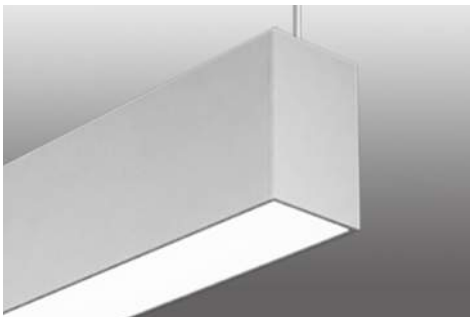
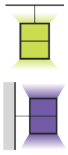
Coronet reserves the right to make design changes.

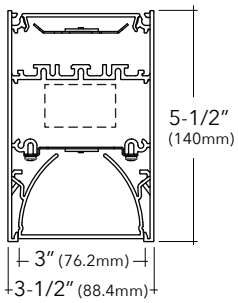
PINNACLE ARCHITECTURAL LIGHTING®

Project Name _____

Date _____ Type _____







EDGE EX3DI

3" Suspended Direct/Indirect Linear

Key Features

- 6063-T6 Extruded aluminum housing
- Room-Side Maintenance for LED system
- 5-year limited warranty covers LED, driver and fixture
- ETL listed conforming to UL 1598 in US and CSA 250 in Canada
- Approved for dry/damp location unless otherwise noted
- Maximum weight is 25 lbs. for a standard 4' fixture
- Buy American Act compliant
- Indigo-Clean available, see Indigo-Clean specification sheets for details
- Product transparency with third-party verified Living Building Challenge (LBC) Declared

Example Part #: EX3DI-BW-HE-830HO-830-26'-AC48G1-U-FSD-1-0-W

EX3DI - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____

DIRECT SHIELDING	INDIRECT SHIELDING	DIRECT SOURCE	INDIRECT SOURCE	LENGTH OR PATTERN	MOUNTING	VOLTAGE	DRIVER	CIRCUITING	BATTERY & EMERGENCY	FINISH	FIXTURE OPTIONS	CONTROLS

DIRECT SHIELDING (__)

A - Satine Lens QS
AL - Drop Lens
HE - High Efficiency QS
BW - Batwing QS
WHE - Asymmetric QS
HED - Descent
MOD - Mod options available
Shielding pg. 2

INDIRECT SHIELDING (___)

HE - High Efficiency QS
BW - Batwing QS
WHE - Asymmetric QS
HEA - Ascent
MOD - Mod options available
Shielding pg. 2

DIRECT SOURCE QS[1] (_____)

_27_ _ - 2700K
_30_ _ - 3000K
_35_ _ - 3500K
_40_ _ - 4000K
CL_ _ _ _ _ _ - Custom Lumens
CW_ _ _ _ _ _ - Custom Watts
MOD - Mod options available
Lumen Output pg. 2

INDIRECT SOURCE QS[1] (_____)

_27_ _ - 2700K
_30_ _ - 3000K
_35_ _ - 3500K
_40_ _ - 4000K
CL_ _ _ _ _ _ - Custom Lumens
CW_ _ _ _ _ _ - Custom Watts
MOD - Mod options available
Lumen Output pg. 3

LENGTH OR PATTERN[2] (____)

_ _ - Individual Fixture QS
_ _ - Continuous Row QS
L _ x _ - L Shape QS
R _ x _ - Rectangle QS
S _ - Square QS
U _ x _ x _ - U-Shape QS
T _ x _ - T Shape
X _ x _ x _ - X Shape
M - Mod Layout
MOD - Mod options available
Length and Pattern pg. 4

MOUNTING[3] (_____)

_AC_ _G_ - (M)AC to Grid QS
_AC_ _JB - (M)AC to J Box QS
_AC_ _ST - (M)AC to Structure QS
WA - Wall Mount QS
_AC5_ _G_ - 5" Non-Power Canopy
_AC5_ _JB - 5" Non-Power Canopy
_SQ_ _G_ - 5" Square Canopy
_SQ_ _JB - 5" Square Canopy
MOD - Mod options available
Mounting pg. 5

VOLTAGE (_)

U - Universal QS
(120 thru 277V)
1 - 120V QS
2 - 277V QS
3 - 347V
Voltage pg. 5

DRIVER (___)

FSD - Factory Select Driver *(1%, 0-10v)* QS
PL2 - Advance Xitanium *(1%, 0-10v)*
OL2 - eldoLED Optotronic *(1%, 0-10v)*
OL4 - eldoLED Optotronic 347v *(1%, 0-10v)*
EE1 - eldoLED ECOdrive *(1%, 0-10v)*
ES1 - eldoLED SOLOdrive *(0.1%, 0-10v)*
LH1- Lutron Hi-lume *(1%, EcoSystem)*
PS1 - Advance Xitanium *(50%/100%)*
MOD - Mod options available
Driver pg. 6

CIRCUITING (_)

1 - Single Circuit QS
2 - Dual Circuit
M - Multi Circuit
E - Emergency QS
(entire fixture)
N - Night Light QS
(entire fixture)
Circuiting pg. 6

BATTERY & EMERGENCY[4] (___)

0 - None QS
_FSB - Factory Select Battery QS
_FSG - Factory Select ALCR
_GI - Iota ETS DR
_GB - Bodine GTD
_ILL - Iota 10W
_PLL - Bodine 10W
Battery and Emergency pg. 7

FINISH (__)

W - White QS
S - Metallic Silver QS
BL - Textured Black QS
BR - Bronze
GR - Graphite
CC - Custom Color
Finish pg. 7

FIXTURE OPTIONS[5] (____)

QS - QuickShip QS
LMRA - Adjustable MR16 *(LED)*
XLED - Fixed Xicato LED
DSP - Customer Supplied Battery/Driver/Sensor
MOD - Mod options available
Fixture Options pg. 7

CONTROLS[6] (___)

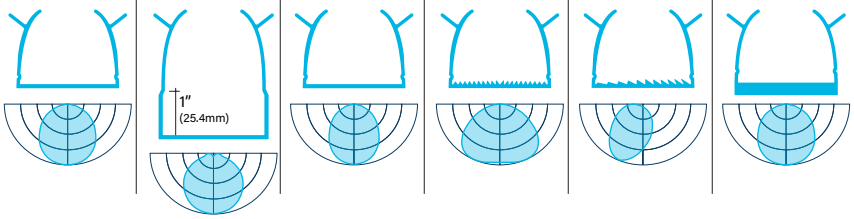
DLMFS - Wattstopper LLLC *(wireless)*
EASYS - Philips EasySense *(wireless)*
SNSLM - Encelium Sensilum *(wireless)*
WVLX - Eaton WaveLinx *(wireless)*
VDO - Lutron Vive Sensor *(wireless)*
VRF - Lutron Vive Connected *(wireless)*
MOD - Mod options available
Controls pg. 8

1. When specifying SOURCE the first _ is for specifying either 8 - 80CRI, or 9 - 90CRI. The ending _ _ are for specifying output, example HO - High Output. See output charts for more information. 2. Individual fixtures come in 2', 3', 4', 5', 6', 7' & 8' lengths. Continuous row come in 1/8" increments. For Mod layouts specify pattern shape and overall dimensions. Example: L6x4: L pattern that is 6'x4'. 3. Specify AC Cable: Standard single AC = AC or Movable AC = MAC; Specify AC length standard AC is 48"; Specify grid: G1=15/16", G9=9/16", GS=Screw Slot. Example: AC48G1 4. Enter quantity for Battery and Emergency, Example 2P. 5. QS must be used in fixture options section of part number to qualify. 1/8" increments not available for QS. LMRF option only available with 120v. 6Controls can only be used with Single Circuit (1) or Emergency Circuit (E). See Controls chart on page 5 for driver options and more information.

Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

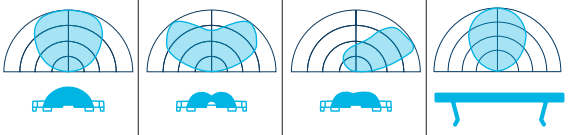
Direct Shielding

A	AL	HE	BW	WHE	HED
Satine Lens	Drop Lens *(foot lengths only)*	High Efficiency	Batwing	Asymmetric	Descent



Indirect Shielding

HE	BW	WHE	HEA
High Efficiency	Batwing	Asymmetric	Ascent *(No MAC mounting foot lengths only)*



Shielding: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Clear lens overlay

Direct Source: White LED[1]

- Specify either 80 or 90 CRI
- Longer lead-time may apply for 90 CRI. Consult factory.
- 90 CRI = R9≥50

Custom Output - Lumens OR Wattage

CL _____	Specify CRI, CCT and desired lumens (i.e. CL835500)	*Specify lumens between standard offering listed below. Lumens are specified per color temp*
CW _____	Specify CRI, CCT and desired wattage (i.e. CW9407)	*Specify watts between standard offering listed below*

80 CRI

	Color	Lumens *per foot*	Shielding[1] **A** Satine		**AL** Drop		**HE** High Efficiency		**BW** Batwing		**WHE** Asymmetric		**HED** Descent	
			LPW	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*
830	3000K	500	108	4.6	118	4.2	123	4.1	120	4.2	124	4.0	106	4.7
830HO	3000K	750	110	6.8	117	6.4	128	5.9	119	6.3	123	6.1	108	6.9
830VHO	3000K	1000	110	9.1	120	8.3	131	7.6	122	8.2	126	7.9	109	9.2
835	3500K	500	111	4.5	122	4.1	127	3.9	123	4.1	123	4.1	110	4.6
835HO	3500K	750	111	6.8	121	6.2	132	5.7	123	6.1	127	5.9	112	6.7
835VHO	3500K	1000	114	8.8	124	8.0	133	7.5	126	7.9	131	7.7	113	8.9
840	4000K	500	111	4.5	122	4.1	127	3.9	123	4.1	123	4.1	110	4.6
840HO	4000K	750	111	6.8	121	6.2	132	5.7	123	6.1	127	5.9	112	6.7
840VHO	4000K	1000	114	8.8	124	8.0	133	7.5	126	7.9	131	7.7	113	8.9

90 CRI

927	2700K	500	89	5.6	98	5.1	104	4.8	99	5.0	102	4.9	88	5.7
927HO	2700K	750	90	8.3	99	7.6	106	7.1	99	7.6	102	7.3	89	8.4
927VHO	2700K	1000	90	11.1	99	10.1	106	9.4	100	10.0	104	9.7	88	11.4
930	3000K	500	97	5.1	104	4.8	113	4.4	106	4.7	109	4.6	96	5.2
930HO	3000K	750	99	7.6	106	7.0	113	6.6	108	6.9	112	6.7	97	7.7
930VHO	3000K	1000	98	10.2	107	9.4	116	8.6	108	9.2	112	8.9	97	10.3
935	3500K	500	97	5.2	104	4.8	113	4.4	105	4.7	109	4.6	96	5.2
935HO	3500K	750	98	7.6	106	7.1	112	6.7	108	7.0	111	6.7	97	7.7
935VHO	3500K	1000	98	10.2	106	9.4	116	8.6	108	9.3	112	9.0	97	10.3
940	4000K	500	97	5.2	104	4.8	113	4.4	105	4.7	109	4.6	96	5.2
940HO	4000K	750	98	7.6	106	7.1	112	6.7	108	7.0	111	6.7	97	7.7
940VHO	4000K	1000	98	10.2	106	9.4	116	8.6	108	9.3	112	9.0	97	10.3

[1]LPW and watts/ft based off 48" fixture size, see IES files for specific fixture length.

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Indirect Source: White LED[1]

- Specify either 80 or 90 CRI
- Longer lead-time may apply for 90 CRI. Consult factory
- 80 CRI = R9≥19 and 90 CRI = R9≥61

Custom Output - Lumens OR Wattage

CL _____	Specify CRI, CCT and desired lumens (i.e. CL835500)	*Specify lumens between standard offering listed below. Lumens are specified per color temp*
CW _____	Specify CRI, CCT and desired wattage (i.e. CW9407)	*Specify watts between standard offering listed below*

80 CRI

	Color	Lumens *per foot*	Shielding[1] **HE** High Efficiency		**BW** Batwing		**WHE** Asymmetric		**HEA** Ascent	
			LPW	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*
830	3000K	500	140	3.6	131	3.8	119	4.2	125	4.0
830HO	3000K	750	146	5.1	135	5.5	119	6.3	125	6.0
830VHO	3000K	1000	147	6.8	137	7.3	122	8.2	128	7.8
835	3500K	500	145	3.4	135	3.7	123	4.1	125	4.0
835HO	3500K	750	151	5.0	141	5.3	122	6.1	129	5.8
835VHO	3500K	1000	148	6.8	141	7.1	126	8.0	133	7.5
840	4000K	500	145	3.4	135	3.7	123	4.1	125	4.0
840HO	4000K	750	151	5.0	141	5.3	122	6.1	129	5.8
840VHO	4000K	1000	148	6.8	141	7.1	126	8.0	133	7.5

90 CRI

927	2700K	500	118	4.2	110	4.5	99	5.1	102	4.9
927HO	2700K	750	118	6.4	110	6.8	98	7.6	104	7.2
927VHO	2700K	1000	121	8.3	113	8.9	100	10.0	105	9.5
930	3000K	500	124	4.0	120	4.2	105	4.7	111	4.5
930HO	3000K	750	129	5.8	120	6.3	107	7.0	111	6.8
930VHO	3000K	1000	132	7.6	123	8.2	108	9.3	114	8.8
935	3500K	500	124	4.0	120	4.2	105	4.8	111	4.5
935HO	3500K	750	128	5.8	119	6.3	107	7.0	110	6.8
935VHO	3500K	1000	132	7.6	122	8.2	107	9.3	113	8.8
940	4000K	500	124	4.0	120	4.2	105	4.8	111	4.5
940HO	4000K	750	128	5.8	119	6.3	107	7.0	110	6.8
940VHO	4000K	1000	132	7.6	122	8.2	107	9.3	113	8.8

[1]LPW and watts/ft based off 48" fixture size, see IES files for specific fixture length.

Source: MOD Options

- Specify **MOD** in the part number for any of the below options
- All RGB_ Source Options will require specific driver and control
- Consult factory for **MOD** specification details, pricing, and lead-time information

		Required Driver	Required Control
MOD	Color Changing RGB LED	EC1/EC4	DMX
	Color Changing RGB-W LED	EC1/EC4	DMX
	2 Channel Tunable White		

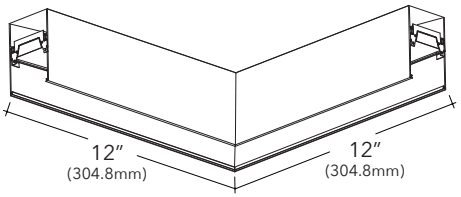
Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

Length

- Individual units cannot be joined, end plates are factory installed and cannot be removed
- For Continuous Runs, add 3/16" (4.7mm) for each end plate or 3/8" (9.5mm) to the overall length of the row
- For patterns, refer to Pattern section on next page

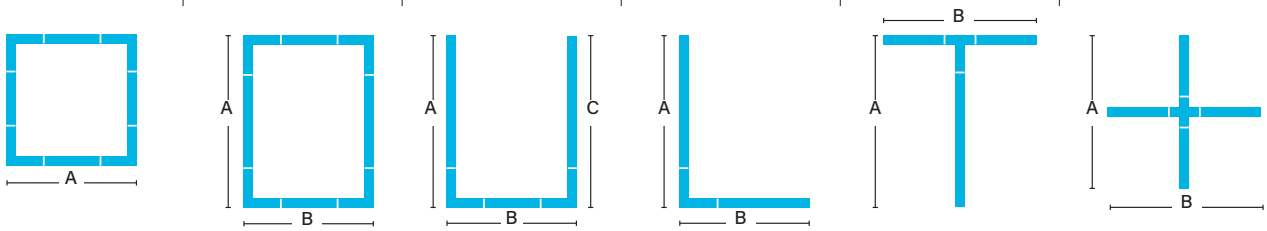
2	3	4	5	6	7	8	_
Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Cont. Run *Specify nominal overall row length to the 1/8" Longer lead-time may apply for lengths to the 1/8". Consult factory.*
24-3/8" (619.1mm)							
36-3/8" (934.8mm)							
48-3/8" (1228.7mm)							
60-3/8" (1533.5mm)							
72-3/8" (1838.3mm)							
84-3/8" (2143.1mm)							
96-3/8" (2447.9mm)							
Specify to the 1/8"							

Pattern



- Specify pattern shape and overall dimensions (includes corner dimensions)
- Refer to dimensions table below for available standard lengths
- All connectors are direct only
- 90 degree horizontal corners are 12"x12" (overall, outside dimension)
- Angles and shapes not shown require Mod Pattern; consult factory
- Only available with "A" or "HE" lens options

S_	R_x_	U_x_x_	L_x_	T_x_	X_x_
Square *Provide A* *Example:* **S4'** *Minimum Length-* *4'x4'*	Rectangle *Provide AxB* *Example:* **R4'x4'** *Minimum Length-* *4'x4'*	U-Shape *Provide AxBxC* *Example:* **U3'x4'x3'** *Minimum Length-* *3'x4'x3'*	L-Shape *Provide AxB* *Example:* **L3'x3'** *Minimum Length-* *3'x3'*	T-Shape *Provide AxB* *Example:* **T3'x5'** *Minimum Length-* *3'x5'*	X-Shape *Provide AxB* *Example:* **X5'x5'** *Minimum Length-* *5'x5'*

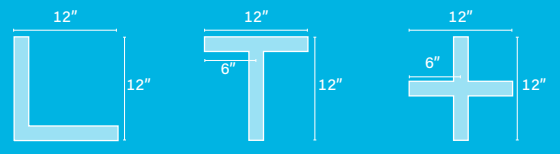


Length or Pattern: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Specify MOD for patterns, lengths or angles not shown above
	45- 180 degree angles
	Single-piece welded housings up to 4' x 4'

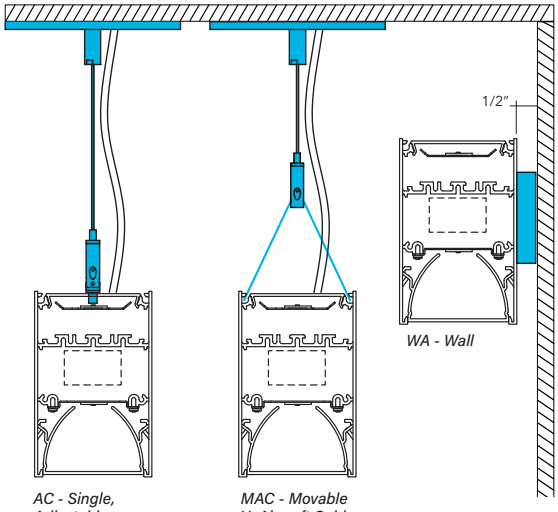
Horizontal Details: Every Connection is 12" x 12" in Overall Dimension



Mounting

- Specify cable length in ordering code (AC48G1)
- Standard specifiable lengths are 48", 120", 240" and 350"
- End plates and power cord attached at factory
- Aircraft cable (AC) mounts on 4' (1219.2mm) and 8' (2438.4mm) centers
- Maximum recommended movable mounting locations are 12" from end of 4' fixture and 18" from end of 8' fixture
- Aircraft Cable supplied with 5" (127mm) power and 2" (50.8mm) non-power canopies
- Canopies and pendants match fixture finish, power cords are white or black depending on fixture finish. See Finish section for additional details.
- Approved for dry/damp location unless otherwise noted
- Refer to installation instructions during installation at the job site
- Maximum fixture weight is 25 lbs for a standard 4' fixture
- AC__GS and MAC__GS – works with screw slot and bolt slot grid ceiling types
- Wall Mount – ADA Compliant, bracket is 1/2" off wall
- MAC options not available with HEA lens option
- MAC options not available with HEA lens option
- For a wall mounted fixture with an indirect asymmetric lens, light will be directed away from the wall as a standard

AC__G1	Aircraft Cable 1" (15/16") T-Bar
AC__G9	Aircraft Cable 9/16" T-Bar
AC__GS	Aircraft Cable Screw Slot T-Bar
AC__JB	Aircraft Cable Junction Box
AC__ST	Aircraft Cable Structure
AC5__G_	Aircraft Cable 5" (127mm) Non-Power Canopy
AC5__JB	Aircraft Cable 5" (127mm) Non-Power Canopy
SQ__G_	Aircraft Cable 5" (127mm) Square Canopy
SQ__JB	Aircraft Cable 5" (127mm) Square Canopy
MAC__G1	Movable AC 1" (15/16") T-Bar
MAC__G9	Movable AC 9/16" T-Bar
MAC__GS	Movable AC Screw Slot T-Bar
MAC__JB	Movable AC Junction Box
MAC__ST	Movable AC Structure
MAC5__G_	Movable AC 5" (127mm) Non-Power Canopy
MAC5__JB	Movable AC 5" (127mm) Non-Power Canopy
MSQ__G_	Movable AC 5" (127mm) Square Canopy
MSQ__JB	Movable AC 5" (127mm) Square Canopy
WA	Wall Mount

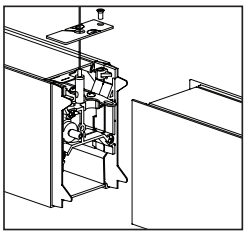


AC - Single, Adjustable Aircraft Cable

MAC - Movable Y- Aircraft Cable

WA - Wall

Straight EDGE Joint System



- The Straight EDGE Joint comes standard for all runs.
- Two connection points – one to cinch fixtures together, the other to perfectly align all fixtures in a run.
- Factory-installed light shields on both sides of the fixture ensure no light leaks.
- Patented.

Mounting: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Recessed to Suspended
	Pendant Pipe

Voltage

- Some EX3DI configurations will not accommodate all voltage options; consult with factory

U	Universal
1	120 volt
2	277 volt
3	347 volt

Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

Driver

- Standard Driver Option = FSD
- Driver Lifetime: 50,000 hours at 25°C ambient operating conditions
- For more driver options see Pinnacle Resource Guide
- Some EX3DI configurations will not accommodate all driver options; consult with factory

0-10V Drivers	
FSD	Factory Select Driver 1%, 0-10v
PL2	Signify Advance Xitanium 1%, 0-10v
PL4	Advance Xitanium 347v 1%, 0-10v, requires 347v
OL2	eldoLED Optotronic, 1%, 0-10v
OL4	eldoLED Optotronic 347v, 1% 0-10v, requires 347v option
EE1	eldoLED ECOdrive 1%, 0-10v Logarithmic
EE2	eldoLED ECOdrive 1%, 0-10v Linear
ES1	eldoLED SOLOdrive 0-10v, 0.1% Logarithmic
ES2	eldoLED SOLOdrive 0-10v, 0% Linear
OL5	Advance Xitanium 1%, 0-10v, AUX, Dim to Off
PL5	eldoLED Optotronic 1%, 0-10v, AUX , Dim to Off
DALI Drivers	
EE3	eldoLED ECOdrive 1%, DALI 2, Logarithmic, DT6
ES3	eldoLED SOLOdrive 0.1%, DALI 2, Logarithmic, DT6
OD1	eldoLED Optotronic 1%, DEXAL
EE4	eldoLED ECOdrive 1%, DALI 2, Linear, DT6
ES4	eldoLED SOLOdrive 0.1%, DALI 2, Linear, DT6
PR1	Advance Xitanium SR, DALI 2, Self powered link
Lutron Drivers	
LH1	Lutron Hi-lume Soft-on, Fade-to-black 1%, EcoSystem, LDE1
Alternate Drivers	
PS1	Signify Advance Xitanium Step Dimming 50%/100%
EH1	ELV 120v only, 0-10v universal

Driver: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Power Over Ethernet

How to specify Circuiting, Battery and Emergency

1

- Select fixture circuiting from options below
- Some EX3DI configurations will not accommodate all circuiting options, consult with factory

Circuiting

1	Single Circuit
2	Dual Circuit
M	Multi Circuit
E	Emergency Circuit only
N	Night Light Circuit only

2 + **3**

- Battery and emergency section options are available in addition to fixture circuit
- Select battery and emergency section options below; factory shop drawing required
- Some EX3DI configurations will not accommodate all circuiting options, consult with factory

Battery and/or Emergency *If Required*

0	No battery or specific emergency section required

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Battery

- Select battery section type if required, indicate total QTY. *Example 2PL*
- 90 minute battery runtime; test button is remote to fixture and requires an additional drop
- No battery option available for 2' or 3' lengths
- Entire direct fixture housing is on battery for lengths up to 5'
- Half of direct fixture is on battery for 6' or 8' housing lengths
- For more battery options available, see Pinnacle Resource Guide

0	No Battery
_FSB	Factory Select Battery (10w option)
_FSBST	Factory Select Battery (10w, Self Testing)
_PLL	Bodine 10w Integral Lithium, Self Testing
_ILL	Iota 10w Integral Lithium, Self Testing

For Approximate Battery Lumen Output

- Multiply battery wattage X fixture LPW shown on Lumen Table
- 92.3 (LPW) x 10 (watts) = 923 battery lumen output

Battery OR Emergency Ordering Examples

- Single circuit, 10w Integral Battery — Ordering Code: 1-1PLL
- Emergency only, 10w Integral Battery — Ordering Code: E-1PLL
- Single circuit, GTD required — Ordering Code: 1-1GB

Emergency

- Select emergency section type if required, indicate total QTY. *Example 1E*
- Combine battery and emergency section ordering codes if both options are selected

_FSG	Factory Select ALCR Emergency Control Device, UNV
_GI	Iota ETS-DR, Emergency Control Device, UNV
_GB	Bodine GTD, Emergency Control Device, 120v or 277v
_E	Emergency circuit section
_N	Night Light circuit section
_L	Life Safety circuit section NO THROUGH WIRE

Finish

- Standard powder-coat textured white, metallic silver, textured black, graphite or bronze painted finish; consult factory for chip of standard paint finishes
- Selecting a fixture finish other than white may impact lumen output; consult factory for more information

W	White *(white cord/white canopy)*
S	Metallic Silver *(white cord/silver canopy)*
BL	Textured Black *(black cord/black canopy)*
BR	Bronze *(white cord/bronze canopy)*
GR	Graphite *(white cord/graphite canopy)*
CC	Custom Color *(white cord/color match canopy)*

Fixture Options

- Additional options to enhance the fixture and finish of the product
- Consult factory for MR16 configurations
- Specify CC-C to match housing. If not specified, canopy will be standard matte white

LMRF	Adjustable MR16 LED *(only available with 120v)*
DSP	Customer Supplied Battery/Driver/Sensor
XLED	Fixed Xicato LED

Fixture Options: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Remote Driver
	End Power Feed

Quick Ship

Shielding	CRI, CCT & Output	Mounting		Voltage		Driver		Circuiting		Battery		Finish	
10-Day													
A - Direct **HE -** Direct **BW -** Direct **WHE -** Direct **HE -** Indirect **BW -** Indirect **WHE -** Indirect	80 CRI, all color temperatures, all lumen packages *See pg 2*	**(M)AC48G_** **(M)AC48JB** **(M)AC48ST** **W** **S**	(M)AC to Grid (M)AC to J-BOX (M)AC to Structure Wall Mount Surface Mount	**U** **1** **2**	Universal (120-277) 120V 277V	**FSD**	Factory Select Driver *(1%, 0-10v)*	**1** **E** **N**	Single Circuit Emergency Night Light	**0** **_FSB**	None Factory Select Battery	**W** **S** **BL**	White Silver Black

All lengths and continuous rows up to 1,000 ft OR 150 individual fixtures. Black QuickShip only available in 4', 6', and 8' individual lengths. Consult factory for larger projects.

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Controls

- Pinnacle Lighting offers easy to specify network control solutions that connect to an intelligent centralized system to maximize lighting energy efficiencies or integral sensors for individual fixture control
- Pinnacle Lighting fixtures ship technology ready; commissioning by others
- Controls can only be used with Single Circuit (**1**) or Emergency Circuit (**E**)
- Contact factory for any non-standard configurations for layout, placement, or EM options
- One drop per sensor typical, consult factory for more information
- Must specify required driver in driver section

	Solution	Components	Network/Sensor	Connection	Required Drivers	Limitation
DLMFS	Legrand Wattstopper LLLC	LMFS-601-W / LMFI-111	Wireless DLM Fixture Sensor	Wireless	OD1, PR1 or 0-10v	0-10v requires interface
EASYS	Philips EasySense	SNS-210	Daylight/PIR Occupancy	Wireless to switches	PR1	Not available with 347 volt
SNSLM	Encelium Sensilum	EN-CLM-PIR-DD-ZB	Encelium, Daylight/PIR Occupancy	Wireless	OD1, OL5	Not available with 347 volt
WLVX	Eaton Wavelinx	SWPD1, NSP3IVMVDC1	WaveLinx WCL, Daylight	Wireless	Any 0-10v	Not available with 347 volt
VDO	Lutron Vive Sensor	DFCSJ-OEM-OCC	Vive, Daylight/PIR Occupancy	Wireless	OD1, PR1	Not available with 347 volt
VRF	Lutron Vive Connected	DFCSJ-OEM-RF	Vive	Wireless	OD1, PR1	Not available with 347 volt

Controls: MOD Options

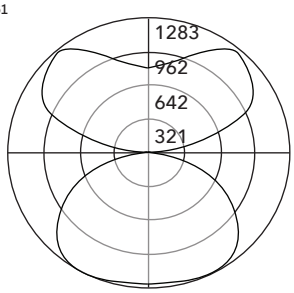
- Specify **MOD** in the part number for any of the below options
- **Control** Options may require specific driver. Refer to the chart below
- Consult factory for **MOD** specification details, pricing, and lead-time information

		Required Driver
MOD	Encelium Sensilum	OD1, OL5
	Enlighted (Wireless) - ENLI	Any 0-10v
	Enlighted (Wireless) - ENLC	Any 0-10v
	Acuity nLight Air Wireless Connected	EE6, ES6

Photometrics

Satine Lens - Open

Test #	SCALED FROM ITL91451 & ITL94661
Catalog #	EX3DI-BW-BW-840VHO-840VHO-4
Lumens	8000 lm
Watts	58.9 w
Efficacy	135.8 LPW



Candela Distribution

Vert Angle	Horizontal Angle 0	22.5	45	67.5	90
0	1268	1268	1268	1268	1268
5	1262	1263	1266	1269	1270
15	1215	1218	1246	1271	1279
25	1117	1130	1197	1258	1280
35	977	1005	1107	1199	1236
45	806	845	963	1065	1100
55	615	656	763	848	872
65	418	449	527	574	580
75	219	237	278	294	292
85	51	61	69	68	67
90	8	54	96	90	97
95	73	144	225	208	195
105	221	300	495	562	539
115	369	438	649	873	925
125	486	570	785	1011	1089
135	572	666	906	1111	1185
145	655	725	934	1131	1207
155	729	768	892	1005	1052
165	784	799	848	892	909
175	811	814	819	823	826
180	814	814	814	814	814

Luminance Data (cd/sq.m)

Angle In Degrees	Average 0-Deg	Average 45-Deg	Average 90-Deg
45	20720	22599	24984
55	19447	21238	23211
65	17871	18722	19356
75	15161	14244	13612
85	10078	6705	5453

[1]Based on ITL Reports 91451, 91463 and 93985.
For all available IES files, please visit our website at pinnacle-ltg.com. Photometry testing in accordance to IESNA-LM-79-08 at an NVLAP accredited testing laboratory. Testing conducted at 25°C ambient conditions.

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Applications & Certificates

Construction: 6063-T6 Extruded aluminum housing. Highly reflective die-formed white painted reflector.

Shielding: Direct: diffuse snap-in acrylic lens, removable for maintenance. Indirect: diffuse snap in lens or over optic. High Efficiency (HE) & Ascent (HEA) are snap in options. Batwing (BW) & Asymmetric (WHE) are over optics.

Mounting: Aircraft cable and wall mount available. Select from 2 aircraft cable options. Select the straight aircraft cable that mounts on 4'-0" (1219.2mm) and 8'-0" (2438.4mm) centers or the movable adjustable Y-cable mount. The Y-Cable design allows for adjustable mounting locations. Aircraft Cable supplied with 5" (127mm) power and 2" (50.8mm) non-power canopies. Refer to installation instructions for appropriate ceiling detail. Canopies are painted white unless otherwise specified. Maximum fixture weight is 25 lbs for a standard 4' fixture..

LED: 25°C test environment. Lumen output/wattage has a margin of +/- 5%; 2' or 3' lengths may have a greater wattage deviation. Luminaire configurations tested in accordance with IES LM-79. Diodes tested in accordance with IES LM-80. Lifetime calculated using IES TM-21. Minimum lifetime greater than 60,000 hours. TM-21-21 Lifetime Rating L70 = >72,000 hours, L90 = 69,700 hours. MacAdam 3-Step Ellipses. For all available IES files, please visit our website at pinnacle-ltg.com.

CRI, CCT & Lumen Output: Not all lumen packages available. Three lumen packages available. Standard, High (HO) and Very High (VHO). Custom outputs are available. Specify custom lumens or watts between standard offering listed on CRI, CCT & Output page. 80 CRI is available for 3000K, 3500K, and 4000K. 90 CRI is available for 2700K, 3000K, 3500K and 4000K. 90 CRI = R9≥50.

Voltage: Universal (U), 120 volt (1), 277 volt (2) and 347 volt (3) options available. Must specify PL4 or OL4 in Driver section when 347 volt (3) is selected. Some EDGE configurations will not accommodate all voltage options; consult with factory.

Driver: Standard Driver Option is Factory Select Driver 0-10V, 1% = FSD. Electronic driver, Power factor is >0.9 with a THD <20%. Driver Lifetime: 50,000 hours at 25°C ambient operating conditions. Ambient operating range: -20°F/-30°C to 122°F/50°C. For more driver options, see Pinnacle Resource Guide. Some EDGE configurations will not accommodate all driver options.

Circuiting: Select from single circuit (1), dual circuit (2), Multi circuit (M), Emergency circuit (E) or Night Light circuit (N). For emergency circuiting situations that require no through wire or circuit separation, Life Safety Circuit should be selected. This will provide a separate power feed and only the Life Safety Circuit in that section. Some EX configurations will not accommodate all circuiting options; consult with factory.

Battery & Emergency: Select battery or emergency options if required. If battery or emergency option is not required, enter 0. Battery duration is 90 minutes as standard. Test button is remote to fixture. For more Battery options, see Pinnacle Resource Guide.

Finish: Standard powder-coat textured white, metallic silver, graphite, textured black or bronze painted finish; consult factory for chip of standard paint finishes. Canopies painted white unless specified differently in the options section of the part number. Contact factory for additional custom color and finish options.

MR16: Ideal for conference rooms, corridors, wall washing, retail spaces and training facilities where accent lighting is required. Fully enclosed compartment eliminates light from entering into our fixture areas. LED lamps are not included. Consult factory for other lamp types. Standard 60 watt max LED electronic transformer (120v), MR16 installed as an independent circuit. MR16 to match fixture voltage. LMRA option not available with 277v. Consult factory for MR16 configurations.

Controls: Standard options available, refer to Controls section table for available options, component part number(s), connection type, required driver and limitations. Mod options available, consult with factory.

Labels: ETL listed conforming to UL 1598 in US and CSA 250 in Canada. Standard and HO lumen packages are approved for dry/damp location unless otherwise noted.

Sustainability: All EDGE models are Living Building Challenge (LBC) Declared with third-party verification. The Declare Label from ILFI provides transparent insights into materials, sourcing, and environmental impact, promoting informed, sustainable choices that benefit both people and the planet. View the label here.

Fixture Weight: Maximum fixture weight is 25 lbs for a standard 4' fixture.

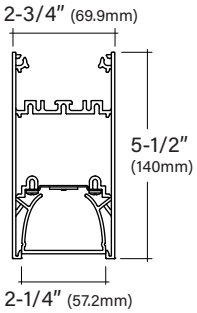
Buy American Act Compliant

Warranty: EX LED offered with a 5-year limited warranty. Covers LED, driver and fixture.

PINNACLE ARCHITECTURAL LIGHTING®

Project Name _____

Date _____ Type _____



EDGE EX2D

2" Suspended Direct Linear

Key Features

- 6063-T6 Extruded aluminum housing
- Room side maintenance for LED system
- 5-year limited warranty covers LED, driver and fixture
- ETL listed conforming to UL 1598 in US and CSA 250 in Canada
- Approved for dry/damp location unless otherwise noted
- Maximum weight is 20 lbs. for a standard 4' fixture
- Buy American Act compliant
- Run lengths available to an 1/8"
- Product transparency with third-party verified Living Building Challenge (LBC) Declared

QUICKSHIP

Example Part #: EX2D-HE-N-830HO-26'-AC48G1-U-FSD-1-0-W

EX2D -	- N	-	-	-	-	-	-	-	-	-	-
DIRECT SHIELDING	*INDIRECT SHIELDING*	*SOURCE*	*LENGTH OR PATTERN*	*MOUNTING*	*VOLTAGE*	*DRIVER*	*CIRCUITING*	*BATTERY & EMERGENCY*	*FINISH*	*FIXTURE OPTIONS*	*CONTROLS*

__	N	_____	____
DIRECT SHIELDING	**INDIRECT SHIELDING**	**SOURCE** QS[1]	**LENGTH OR PATTERN**[2]
A - Satine Lens QS **AL** - Drop Lens **HE** - High Efficiency QS **BW** - Batwing QS **WHE** - Asymmetric QS **HED** - Descent *Shielding pg. 2*	**N** - None QS *Shielding pg. 2*	**_27__** - 2700K **_30__** - 3000K **_35__** - 3500K **_40__** - 4000K **CL_____** - Custom Lumens **CW_____** - Custom Watts **MOD** - Mod options available *Lumen Output pg. 2*	**__** - Individual Fixture QS **__** - Continuous Row QS **S_** - Square QS **R_x_** - Rectangle QS **L_x_** - L Shape QS **U_x_** - U-Shape QS **T_x_** - T-Shape **X_x_x_** - X-Shape **MOD** - Mod options available *Length and Pattern pg. 3*

_____	_	___	_
MOUNTING[3]	**VOLTAGE**	**DRIVER**	**CIRCUITING**
_AC_ _G_ - (M)AC to Grid QS **_AC_ _JB** - (M)AC to J Box QS **_AC_ _ST** - (M)AC to Structure QS **_AC5_ _G_** - 5" Non-Power Canopy **_AC5_ _JB** - 5" Non-Power Canopy **_SQ_ _G_** - 5" Square Canopy **_SQ_ _JB** - 5" Square Canopy **WA** - Wall Mount QS **S** - Surface Mount QS **MOD** - Mod options available *Mounting pg. 4*	**U** - Universal *(120 thru 277V)* QS **1** - 120V QS **2** - 277V QS **3** - 347V *Voltage pg. 4*	**FSD** - Factory Select Driver *(1%, 0-10v)* QS **PL2** - Advance Xitanium *(1%, 0-10v)* **OL2** - eldoLED Optotronic *(1%, 0-10v)* **OL4** - eldoLED Optotronic 347v *(1%, 0-10v)* **EE1** - eldoLED ECOdrive *(1%, 0-10v)* **ES1** - eldoLED SOLOdrive *(0.1%, 0-10v)* **LH1**- Lutron Hi-lume *(1%, EcoSystem)* **PR1** - Advance Xitanium SR **MOD** - Mod options available *Driver pg. 5*	**1** - Single Circuit QS **M** - Multi Circuit **E** - Emergency *(entire fixture)* QS **N** - Night Light *(entire fixture)* QS *Circuiting pg. 6*

___	__	____	___
BATTERY & EMERGENCY[4]	**FINISH**	**FIXTURE OPTIONS**[5]	**CONTROLS**[6]
0 - None QS **_FSB** - Factory Select Battery QS **_FSG** - Factory Select ALCR **_GI** - Iota ETS DR **_GB** - Bodine GTD **_ILL** - Iota 10W **_PLL** - Bodine 10W **_E** - Emergency Section **_N** - Night Light Section **_L** - Life Safety Section *Battery and Emergency pg. 5-6*	**W** - White QS **S** - Metallic Silver QS **BL** - Textured Black QS **BR** - Bronze **GR** - Graphite **CC** - Custom Color *Finish pg. 6*	**QS** - QuickShip QS **TC** - Indirect Top Cover *(ac mounting only)* **DSP** - Customer Supplied Battery/Driver/Sensor **MOD** - Mod options available *Fixture Options pg. 6*	**DLMFC** - Wattstopper DLM *(wired)* **DLMFS** - Wattstopper LLLC *(wireless)* **EASYS** - Philips EasySense *(wireless)* **SNSLM** - Encelium Sensilum *(wireless)* **WVLX** - Eaton Wavelinx *(wireless)* **VDO** - Lutron Vive Sensor *(wireless)* **VRF** - Lutron Vive Connected *(wireless)* **ENL_** - Enlighted *(wireless)* **MOD** - Mod options available *Controls pg. 7*

1. When specifying SOURCE the first _ is for specifying either 8 - 80CRI, or 9 - 90CRI. The ending _ _ are for specifying output, example HO - High Output. See output charts for more information. 2. Individual fixtures come in 2', 3', 4', 5', 6', 7' & 8' lengths. Continuous row come in 1/8" increments. For Mod layouts specify pattern shape and overall dimensions. Example: L6x4: L pattern that is 6'x4'. 3. Specify AC Cable: Standard single AC = AC or Movable AC = MAC; Specify AC length standard AC is 48"; Specify grid: G1=15/16", G9=9/16", GS=Screw Slot. Example: AC48G1 4. Enter quantity for Battery and Emergency, Example 2P. 5. QS must be used in fixture options section of part number to qualify. 1/8" increments not available for QS. LMRF option only available with 120v. 6Controls can only be used with Single Circuit (1) or Emergency Circuit (E). See Controls chart on page 5 for driver options and more information.

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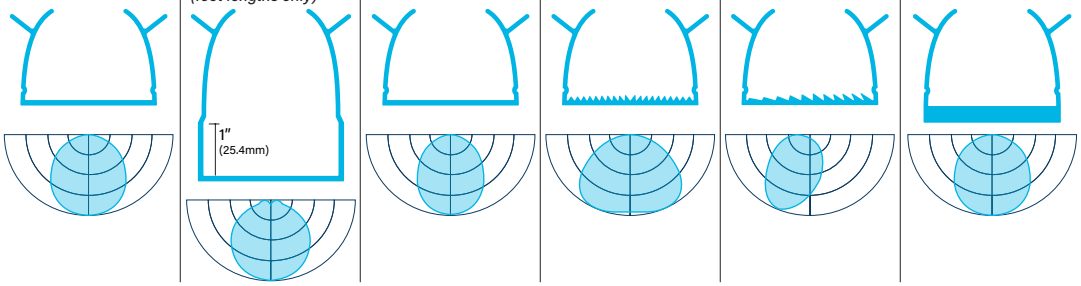
Direct Shielding

A	AL	HE	BW	WHE	HED
Satine Lens	Drop Lens *(foot lengths only)*	High Efficiency	Batwing	Asymmetric	Descent



Indirect Shielding

N
None

Source: White LED[1]

- Specify either 80 or 90 CRI
- Longer lead-time may apply for 90 CRI. Consult factory
- 90 CRI = R9≥50

Custom Output - Lumens OR Wattage

CL _____	Specify CRI, CCT and desired lumens (i.e. CL835500)	*Specify lumens between standard offering listed below. Lumens are specified per color temp*
CW _____	Specify CRI, CCT and desired wattage (i.e. CW9407)	*Specify watts between standard offering listed below*

80 CRI

	Color	Lumens *per foot*	Shielding[1] **A** Satine		**AL** Drop		**HE** High Efficiency		**BW** Batwing		**WHE** Asymmetric		**HED** Descent	
			LPW	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*
830	3000K	500	101	4.9	101	4.9	119	4.2	119	4.2	116	4.3	98	5.1
830HO	3000K	750	101	7.4	103	7.3	119	6.3	119	6.3	116	6.5	99	7.6
830VHO	3000K	1000	103	9.8	105	9.5	122	8.2	122	8.2	119	8.4	99	10.1
835	3500K	500	102	4.9	105	4.8	123	4.1	123	4.1	120	4.2	101	5.0
835HO	3500K	750	104	7.2	107	7.0	123	6.1	123	6.1	120	6.3	101	7.5
835VHO	3500K	1000	106	9.4	107	9.3	126	8.0	126	7.9	123	8.2	102	9.8
840	4000K	500	102	4.9	105	4.8	123	4.1	123	4.1	120	4.2	101	5.0
840HO	4000K	750	104	7.2	107	7.0	123	6.1	123	6.1	120	6.3	101	7.5
840VHO	4000K	1000	106	9.4	107	9.3	126	8.0	126	7.9	123	8.2	102	9.8

90 CRI

927SO	2700K	500	82	6.1	83	6.0	99	5.1	99	5.1	96	5.2	79	6.4
927HO	2700K	750	84	9.0	85	8.8	98	7.6	99	7.6	98	7.7	80	9.3
927VHO	2700K	1000	82	12.2	83	12.0	100	10.0	100	10.0	97	10.3	79	12.7
930SO	3000K	500	89	5.6	91	5.5	105	4.7	106	4.7	103	4.9	86	5.8
930HO	3000K	750	91	8.3	93	8.1	108	7.0	108	7.0	105	7.1	88	8.5
930VHO	3000K	1000	90	11.1	92	10.8	108	9.3	108	9.2	107	9.4	86	11.6
935SO	3500K	500	89	5.6	91	5.5	105	4.8	105	4.8	103	4.9	86	5.8
935HO	3500K	750	90	8.3	92	8.1	107	7.0	107	7.0	105	7.2	88	8.6
935VHO	3500K	1000	90	11.1	92	10.9	108	9.3	108	9.3	106	9.4	86	11.7
940SO	4000K	500	89	5.6	91	5.5	105	4.8	105	4.8	103	4.9	86	5.8
940HO	4000K	750	90	8.3	92	8.1	107	7.0	107	7.0	105	7.2	88	8.6
940VHO	4000K	1000	90	11.1	92	10.9	108	9.3	108	9.3	106	9.4	86	11.7

[1]LPW and watts/ft based off 48" fixture size.

Direct Source: MOD Options

- Specify **MOD** in the part number for any of the below options
- All RGB_ Source Options will require specific driver and control
- Consult factory for **MOD** specification details, pricing, and lead-time information

		Required Driver	Required Control
MOD	Color Changing RGB LED	EC1/EC4	DMX
	Color Changing RGB-W LED	EC1/EC4	DMX
	2 Channel Tunable White		

Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

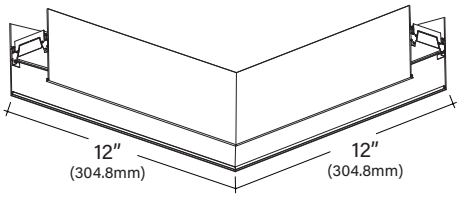
Length

- For Continuous Runs, add 3/16″ (4.7mm) for each end plate or 3/8″ (9.5mm) to the overall length of the row

2	3	4	5	6	7	8	–
Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Cont. Run *Specify nominal overall row length to the 1/8″ Longer lead-time may apply for lengths to the 1/8″. Consult factory.*

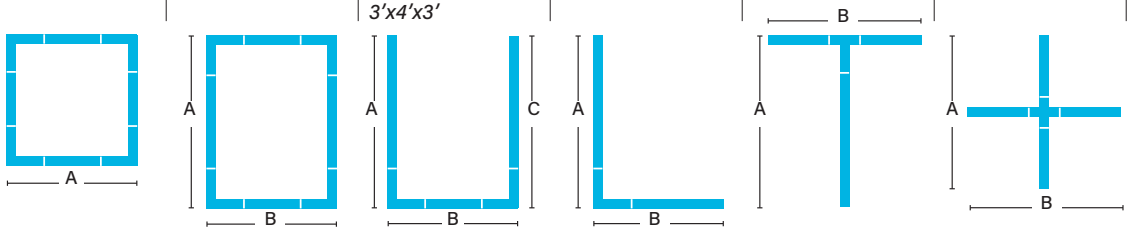
24-3/8″ (619.1mm)
36-3/8″ (934.8mm)
48-3/8″ (1228.7mm)
60-3/8″ (1533.5mm)
72-3/8″ (1838.3mm)
84-3/8″ (2143.1mm)
96-3/8″ (2447.9mm)
Specify to the 1/8″

Pattern



- Specify pattern shape and overall dimensions (includes corner dimensions)
- Refer to dimensions table below for available standard lengths
- All connectors are direct only
- 90 degree horizontal corners are 12″x12″ (overall, outside dimension)
- Angles and shapes not shown require Mod Pattern; consult factory
- Only available with "A" or "HE" lens options

S_	R_x_	U_x_x_	L_x_	T_x_	X_x_	M
Square *Provide A dimension* *Example:* **S4′** *Minimum Length-4′x4′*	Rectangle *Provide AxB dimensions* *Example:* **R4′x4′** *Minimum Length-4′x4′*	U-Shape *Provide AxBxC dimensions* *Example:* **U3′x4′x3′** *Minimum Length-3′x4′x3′*	L-Shape *Provide AxB dimensions* *Example:* **L3′x3′** *Minimum Length-3′x3′*	T-Shape *Provide AxB dimensions* *Example:* **T3′x5′** *Minimum Length-3′x5′*	X-Shape *Provide AxB dimensions* *Example:* **X5′x5′** *Minimum Length-5′x5′*	Mod Layout *For patterns or lengths not shown or standard*

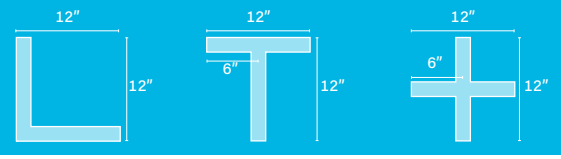


Length or Pattern: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Specify MOD for patterns, lengths or angles not shown above
	45- 180 degree angles
	Single-piece welded housings up to 4′ x 4′

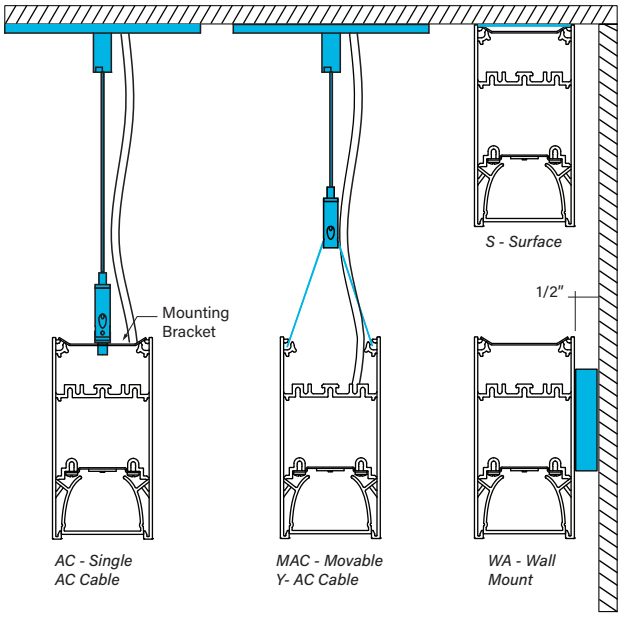
Horizontal Details: Every Connection is 12″ x 12″ in Overall Dimension



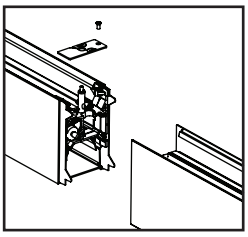
Mounting

- Specify cable length in ordering code (AC48G1)
- Standard adjustable cable. Specify 48", 120", 240" or 350"
- End plates and power cord attached at factory
- Aircraft cable (AC) mounts on 4' (1219.2mm) and 8' (2438.4mm) centers
- Maximum recommended movable mounting locations are 12" from end of 4' fixture and 18" from end of 8' fixture
- AC Cable supplied with 5" (127mm) power and 2" (50.8mm) non-power canopies
- Canopies and pendants match fixture finish, power cords are white or black depending on fixture finish. See Finish section for additional details.
- Approved for dry/damp location unless otherwise noted
- Refer to installation instructions during installation at the job site
- Maximum fixture weight is 20 lbs for a standard 4' fixture
- Top Cover is optional on AC mounting fixtures, Top Cover is standard on others

AC__G1	Aircraft Cable 1" (15/16") T-Bar
AC__G9	Aircraft Cable 9/16" T-Bar
AC__GS	Aircraft Cable Screw Slot T-Bar
AC__JB	Aircraft Cable Junction Box
AC__ST	Aircraft Cable Structure
AC5__G_	Aircraft Cable 5" (127mm) Non-Power Canopy
AC5__JB	Aircraft Cable 5" (127mm) Non-Power Canopy
SQ__G_	Aircraft Cable 5" (127mm) Square Canopy
SQ__JB	Aircraft Cable 5" (127mm) Square Canopy
MAC__G1	Movable AC 1" (15/16") T-Bar
MAC__G9	Movable AC 9/16" T-Bar
MAC__GS	Movable AC Screw Slot T-Bar
MAC__JB	Movable AC Junction Box
MAC__ST	Movable AC Structure
MAC5__G_	Movable AC 5" (127mm) Non-Power Canopy
MAC5__JB	Movable AC 5" (127mm) Non-Power Canopy
MSQ__G_	Movable AC 5" (127mm) Square Canopy
MSQ__JB	Movable AC 5" (127mm) Square Canopy
WA	Wall Mount
S	Surface Mount



Straight EDGE Joint System



- The Straight EDGE Joint comes standard for all runs.
- Two connection points – one to cinch fixtures together, the other to perfectly align all fixtures in a run.
- Factory-installed light shields on both sides of the fixture ensure no light leaks.
- Patented.

Mounting: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Recessed to Suspended
	Pendant Pipe

Voltage

- Some EX2D configurations will not accommodate all voltage options; consult with factory

U	Universal
1	120 volt
2	277 volt
3	347 volt

Driver

- Standard Driver Option = FSD
- Driver Lifetime: 50,000 hours at 25°C ambient operating conditions
- For more driver options see Pinnacle Resource Guide
- Some EX2D configurations will not accommodate all driver options; consult with factory

0-10V Drivers	
FSD	Factory Select Driver 1%, 0-10v
PL2	Signify Advance Xitanium 1%, 0-10v
PL4	Advance Xitanium 347v 1%, 0-10v, requires 347v
OL2	eldoLED Optotronic, 1%, 0-10v
OL4	eldoLED Optotronic 347v, 1% 0-10v, requires 347v option
EE1	eldoLED ECOdrive 1%, 0-10v Logarithmic
EE2	eldoLED ECOdrive 1%, 0-10v Linear
ES1	eldoLED SOLOdrive 0-10v, 0.1% Logarithmic
ES2	eldoLED SOLOdrive 0-10v, 0% Linear
OL5	Advance Xitanium 1%, 0-10v, AUX, Dim to Off
PL5	eldoLED Optotronic 1%, 0-10v, AUX , Dim to Off
DALI Drivers	
EE3	eldoLED ECOdrive 1%, DALI 2, Logarithmic, DT6
ES3	eldoLED SOLOdrive 0.1%, DALI 2, Logarithmic, DT6
OD1	eldoLED Optotronic 1%, DEXAL
EE4	eldoLED ECOdrive 1%, DALI 2, Linear, DT6
ES4	eldoLED SOLOdrive 0.1%, DALI 2, Linear, DT6
PR1	Advance Xitanium SR, DALI 2, Self powered link
Lutron Drivers	
LH1	Lutron Hi-lume Soft-on, Fade-to-black 1%, EcoSystem, LDE1
Alternate Drivers	
PS1	Signify Advance Xitanium Step Dimming 50%/100%
EH1	ELV 120v only, 0-10v universal

Driver: MOD Options

- Specify **MOD** in the part number for any of the below options
- MOD specifications are subject to longer lead-times. Consult factory for more information

MOD	Power Over Ethernet

How to Specify Circuiting, Battery and Emergency

1

- Select fixture circuiting from options below
- Some EX2D configurations will not accommodate all circuiting options, consult with factory

Circuiting

1	Single Circuit
M	Multi Circuit
E	Emergency Circuit only
N	Night Light Circuit only

2 + **3**

- Battery and emergency section options are available in addition to fixture circuit
- Select battery and emergency section options below; factory shop drawing required
- Some EX2D configurations will not accommodate all circuiting options, consult with factory

Battery and/or Emergency *If Required*

0	No battery or specific emergency section required

Battery

- Select battery section type if required, indicate total QTY. *Example 2PL*
- 90 minute battery runtime; test button location dependent on configuration, consult factory
- No battery option available for 2' lengths
- Entire direct fixture housing is on battery for lengths up to 5'
- Half of direct fixture is on battery for 6' or 8' housing lengths
- For more battery options available, see Pinnacle Resource Guide

0	No Battery
_FSB	Factory Select Battery (10w option)
_FSBST	Factory Select Battery (10w, Self Testing)
_PLL	Bodine 10w Integral Lithium, Self Testing
_ILL	Iota 10w Integral Lithium, Self Testing

For Approximate Battery Lumen Output
- Multiply battery wattage X fixture LPW shown on Lumen Table
- 92.3 (LPW) x 10 (watts) = 923 battery lumen output

Battery OR Emergency Ordering Examples
- Single circuit, 10w Integral Battery — Ordering Code: 1-1FSB
- Emergency only, 10w Integral Battery — Ordering Code: E-1PLL
- Single circuit, GTD required — Ordering Code: 1-1GB

Emergency

- Select emergency section type if required, indicate total QTY. *Example 1E*
- Combine battery and emergency section ordering codes if both options are selected

_FSG	Factory Select ALCR Emergency Control Device, UNV
_GI	Iota ETS-DR, Emergency Control Device, UNV
_GB	Bodine GTD, Emergency Control Device, 120v or 277v
_E	Emergency circuit section
_N	Night Light circuit section
_L	Life Safety circuit section NO THROUGH WIRE

Finish

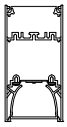
- Standard powder-coat textured white, metallic silver, textured black, graphite or bronze painted finish; consult factory for chip of standard paint finishes
- Selecting a fixture finish other than white may impact lumen output; consult factory for more information

W	White *(white cord/white canopy)*
S	Metallic Silver *(white cord/silver canopy)*
BL	Textured Black *(black cord/black canopy)*
BR	Bronze *(white cord/bronze canopy)*
GR	Graphite *(white cord/graphite canopy)*
CC	Custom Color *(white cord/color match canopy)*

Fixture Options

- Additional options to enhance the fixture and finish of the product

QS	Quick Ship
DSP	Customer Supplied Battery/Driver/Sensor
TC	Indirect Top Cover *(ac mounting only)*



*Cross section with TC Option

Fixture Options: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Remote Driver
	End Power Feed

Quick Ship

Shielding	CRI, CCT & Output	Mounting		Voltage		Driver		Circuiting		Battery		Finish	
10-Day													
A **HE** **BW** **WHE**	80 CRI, all color temperatures, all lumen packages *See pg 2*	**(M)AC48G_** **(M)AC48JB** **(M)AC48ST** **W** **S**	(M)AC to Grid (M)AC to J-BOX (M)AC to Structure Wall Mount Surface Mount	**U** **1** **2**	Universal (120-277) 120V 277V	**FSD**	Factory Select Driver *(1%, 0-10v)*	**1** **E** **N**	Single Circuit Emergency Night Light	**0** **_FSB**	None Factory Select Battery	**W** **S** **BL**	White Silver Black

All lengths and continuous rows up to 1,000 ft OR 150 individual fixtures. Black QuickShip only available in 4', 6', and 8' individual lengths. Consult factory for larger projects.

Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

Controls

- Pinnacle Lighting offers easy to specify network control solutions that connect to an intelligent centralized system to maximize lighting energy efficiencies or integral sensors for individual fixture control
- Pinnacle Lighting fixtures ship technology ready; commissioning by others
- Controls can only be used with Single Circuit (**1**) or Emergency Circuit (**E**)
- Contact factory for any non-standard configurations for layout, placement, or EM options
- One drop per sensor typical, consult factory for more information

	Solution	Components	Network/Sensor	Connection	Required Drivers	Limitation
DLMFC	Legrand Wattstopper DLM	LMFC-011	Digital Lighting Management (DLM)	Wired, one RJ45 ports	OL2, OL4	Not available with Battery
DLMFS	Legrand Wattstopper LLLC	LMFS-601-W / LMFI-111	Wireless DLM Fixture Sensor	Wireless	OD1, PR1, 0-10v	0-10v requires interface
EASYS	Philips EasySense	SNS-210	Daylight/PIR Occupancy	Wireless to switches	PR1	Not available with 347 volt
SNSLM	Encelium Sensilum	EN-CLM-PIR-DD-ZB	Encelium, Daylight/PIR Occupancy	Wireless	OD1, OL5	Not available with 347 volt
WLVX	Eaton Wavelinx	SWPD1, NSP3IVMVDC1	WaveLinx WCL, Daylight	Wireless	Any 0-10v	Not available with 347 volt
VDO	Lutron Vive Sensor	DFCSJ-OEM-OCC	Vive, Daylight/PIR Occupancy	Wireless	OD1, PR1	Not available with 347 volt
VRF	Lutron Vive Connected	DFCSJ-OEM-RF	Vive	Wireless	OD1, PR1	Not available with 347 volt
ENLI	Enlighted	SU-5E-IOT, CU-4E	Enlighted, Daylight/PIR Occupancy	Wireless	Any 0-10v	Not available with 347 volt
ENLC	Enlighted	SU-5E-CL, CU-4E	Enlighted, Daylight/PIR Occupancy	Wireless	Any 0-10v	Not available with 347 volt

Controls: MOD Options

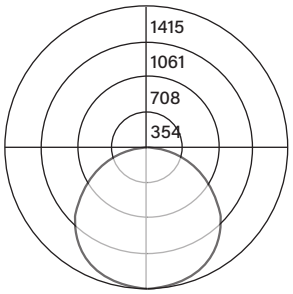
- Specify **MOD** in the part number for any of the below options
- **Control** Options may require specific driver. Refer to the chart below
- Consult factory for **MOD** specification details, pricing, and lead-time information

		Required Driver
MOD	Encelium Sensilum	OD1, OL5
	Enlighted (Wireless) - ENLI	Any 0-10v
	Enlighted (Wireless) - ENLC	Any 0-10v
	Acuity nLight Air Wireless Connected	EE6, ES6

Photometrics

Satine Lens

Test #	ITL91441
Catalog #	EX2D-A-840VHO-4
Lumens	3986 lm
Watts	37.5 W
Efficacy	106 LPW



Candela Distribution

Vert Angle	Horizontal Angle 0	22.5	45	67.5	90
0	1415	1415	1415	1415	1415
5	1410	1409	1408	1407	1406
10	1393	1387	1388	1387	1386
15	1365	1353	1356	1355	1352
20	1323	1307	1313	1312	1306
25	1271	1252	1258	1254	1249
30	1207	1187	1191	1187	1182
35	1132	1115	1117	1108	1103
40	1050	1032	1032	1023	1017
45	957	943	939	929	923
50	858	843	837	827	823
55	752	737	729	717	712
60	636	623	613	601	598
65	518	504	495	484	479
70	392	384	370	361	360
75	270	261	251	244	239
80	152	146	140	135	133
85	54	54	50	46	47
90	0	0	0	0	0

Luminance Data (cd/sq.m)

Angle In Degrees	Average 0-Deg	Average 45-Deg	Average 90-Deg
45	19610	19241	18913
55	18997	18416	17986
65	17760	16971	16422
75	15115	14052	13380
85	8977	8312	7814

For all available IES files, please visit our website at pinnacle-ltg.com. Photometry testing in accordance to IESNA-LM-79-08 at an NVLAP accredited testing laboratory. Testing conducted at 25°C ambient conditions.

Applications & Certificates

Construction: 6063-T6 Extruded aluminum housing. Highly reflective steel white painted reflector.

Shielding: Diffuse snap-in acrylic lens, removable for maintenance.

Mounting: Aircraft cable and wall mount available. Select from 2 aircraft cable options. Select the straight aircraft cable that mounts on 4'-0" (1219.2mm) and 8'-0" (2438.4mm) centers or the movable adjustable Y-cable mount. The Y-Cable design allows for adjustable mounting locations. Aircraft Cable supplied with 5" (127mm) power and 2" (50.8mm) non-power canopies. Refer to installation instructions for appropriate ceiling detail. Canopies are painted white unless otherwise specified. Maximum fixture weight is 20 lbs. for a standard 4' fixture.

LED: 25°C test environment. Lumen output/wattage has a margin of +/- 5%; 2' or 3' lengths may have a greater wattage deviation. Luminaire configurations tested in accordance with IES LM-79. Diodes tested in accordance with IES LM-80. Lifetime calculated using IES TM-21. Minimum lifetime greater than 60,000 hours. TM-21-21 Lifetime Rating L70 = >72,000 hours, L90 = 69,700 hours. MacAdam 3-Step Ellipses. For all available IES files, please visit our website at pinnacle-ltg.com.

CRI, CCT & Output: Not all lumen packages available. Three lumen packages available. Standard, High (HO) and Very High (VHO). Custom outputs are available. Specify custom lumens or watts between standard offering listed on CRI, CCT & Output page. 80 CRI is available for 3000K, 3500K, and 4000K. 90 CRI is available for 2700K, 3000K, 3500K and 4000K. 90 CRI = R9≥50.

Voltage: Universal (U), 120 volt (1), 277 volt (2) and 347 volt (3) options available. Must specify PL4 or OL4 in Driver section when 347 volt (3) is selected. Some EDGE configurations will not accommodate all voltage options; consult with factory.

Driver: Standard Driver Option is Factory Select Driver 0-10V, 1% = FSD. Electronic driver, Power factor is >0.9 with a THD <20%. Driver Lifetime: 50,000 hours at 25°C ambient operating conditions. Ambient operating range: -20°F/-30°C to 122°F/50°C. For more driver options, see Pinnacle Resource Guide. Some EDGE configurations will not accommodate all driver options.

Circuiting: Select from single circuit (1), Multi circuit - For multiple circuiting and zone control, requires factory shop drawing (M), Emergency circuit (E), Life Safety (L) or Night Light circuit (N). For emergency circuiting situations that require no through wire or circuit separation, Life Safety Circuit should be selected. This will provide a separate power feed and only the Life Safety Circuit in that section. Some EDGE configurations will not accommodate all circuiting options; consult with factory.

Battery & Emergency: Select battery or emergency options if required. If battery or emergency option is not required, enter 0. Battery duration is 90 minutes as standard. Test button location dependent on configuration, consult factory. For more Battery options, see Pinnacle Resource Guide.

Finish: Standard powder-coat textured white, metallic silver, textured black, graphite or bronze painted finish; consult factory for chip of standard paint finishes or for additional custom color and finish options.

Controls: Standard options available, refer to Controls section table for available options, component part number(s), connection type, required driver and limitations. Mod options available, consult with factory.

Labels: UL and cUL 2108 or 1598 listed depending on product configuration. Standard, HO and VHO lumen packages are IC Rated, approved for dry/damp location unless otherwise noted.

Sustainability: All EDGE models are Living Building Challenge (LBC) Declared with third-party verification. The Declare Label from ILFI provides transparent insights into materials, sourcing, and environmental impact, promoting informed, sustainable choices that benefit both people and the planet. View the label here.

Fixture Weight: Maximum fixture weight is 20lbs per 4' fixture.

Buy American Act Compliant

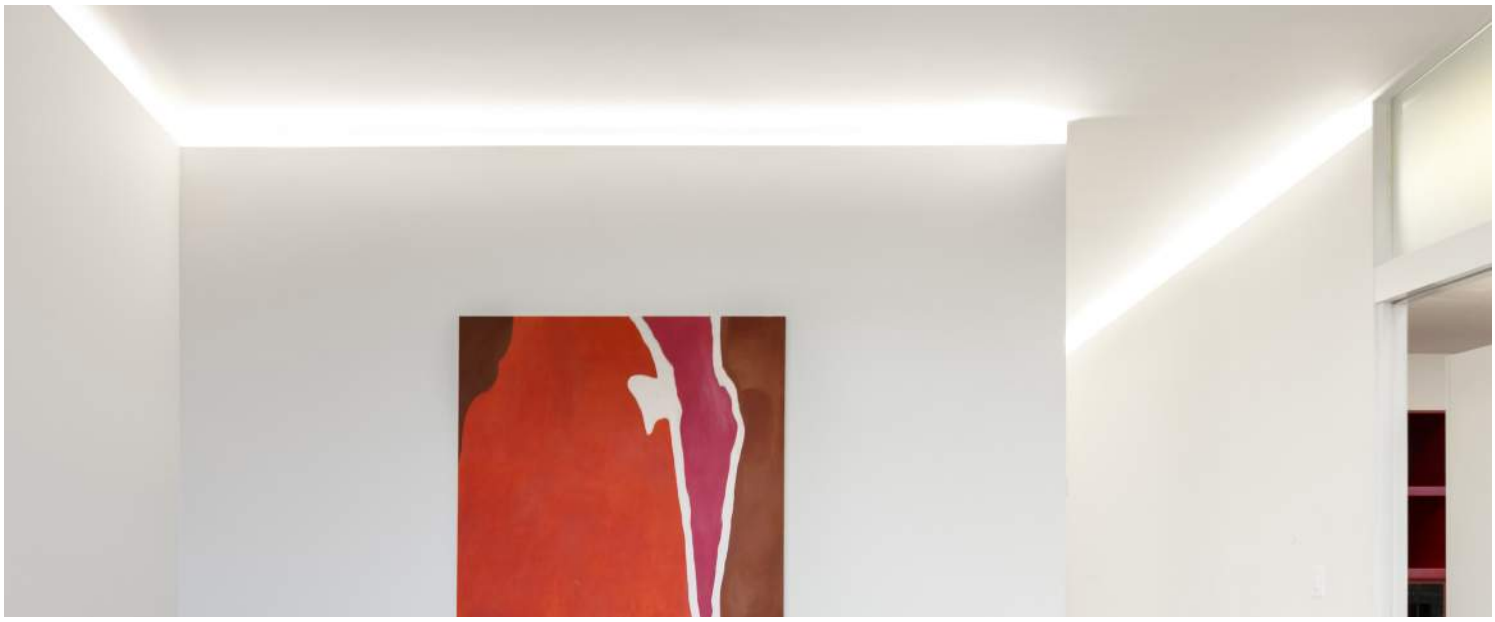
Warranty: EDGE LED offered with a 5-year limited warranty. Covers LED, driver and fixture.

VERGE WALL 24VDC

24VDC PLASTER-IN LED SYSTEM

BY GREGORY KAY, ORIGINAL DESIGNER OF 5/8" DRYWALL PRODUCTS | MADE IN AMERICA

REV 10.06.21



DESCRIPTION

Verge Wall, a slim, plaster-in aluminum channel with a 4" paintable aluminum backer plate, highlights the transition where two drywall surfaces join together, while emitting ambient illumination. The 24VDC linear LED system mounts directly to studs without joist modification and plasters into 5/8" or thicker drywall. Verge is sold in 1' increments up to 40' and field cuttable to any length. Several color temperature options are available, including 2200K-5700K, Warm Dim and Tunable White **(2K6K & 27K6)**. High CRI commercial-grade White or Dynamic Color Changing LED Soft Strip projects a clean line of light. Coordinate installation with electrical and drywall contractors. Includes a 5-year pro-rated warranty. For custom quotes and layout assistance, send drawings to design@PureEdgeLighting.com .

REMOTE POWER SUPPLIES*, DIMMERS & CONTROLS (SOLD SEPARATELY)

- 0-10 Volt Dimming **(0-10V)**
- Uni Driver: Universal Dimming **(ELV, 0-10V, TRIAC)**
- Lutron Hi-Lume®
- Electronic Low Voltage Dimming **(ELV)**†
- Dynamic Color Changing **(DMX)**

*In-Wall Mounting Kits available for select power supplies
**Dynamic/Tunable White Requires two dimmers (one for each color temperature) or use our proprietary Tunable White Controller CDMX-1
†With N-Lite Dimming Do Not use ELV power supply's, use only 0-10 volt or Uni drivers power supplies

MAXIMUM LENGTHS BEFORE RE-FEEDING

- 2WDC, 2.5 watts per foot - 40'
- 5WDC, 4.4 watts per foot - 20'
- 7WDC, 7.5 watts per foot - 12'

INCLUDED COMPONENTS

Junction Box, Adjustable Mounting Bars, Backer Plate, Verge Wall Channel(s), Drywall Screws, LED Soft Strip, and Lens(es)

DESIGN NOTE

Verge Wall may be installed on a single surface for Toe-Kick and Cove lighting applications. Ambient and harmonious, the plaster-in LED system blends into 5/8" thick drywall to enhance the contemporary aesthetic of interior spaces. Verge offers unsurpassed flexibility that transforms interiors into thoughtful, unique works of art.

LAMP

- 7 Static White Color Temperatures 22K-57K
- Warm Dim: 27D and 30D dim down to 1900K, resembling incandescent light sources
- Dynamic/Tunable White: 2K6K and 27K6 allow for independent control of color temperatures and dimming
- Average life: 50,000 hours

APPLICATIONS

Indoor damp or dry locations only. Wall Mount for use as Cove lighting or use at the Floor for Floating Wall effects. Ideal applications include Residential, Commercial, Retail, and Hospitality environments.

COMPLIANCE

ETL, Class 2, Damp Location, Made in USA. 1**-hour fire rating uses Two pieces of Type X Gypsum board, for 2-Hour fire rating use Three pieces of Type X Gypsum board.**

Use our Configurator to see List Price, Complete Ordering Code and Overall Length. Verge Wall

PureEdge is the Original Designer of 5/8" Drywall Products, Backed by Over 30 Years of Precision Manufacturing and Design.

System		Watts Per Foot		Length in Feet		Color Temperature
VG	–	2WDC	–	1-40FT	–	27K

VG	Verge Wall	**2WDC**	2.5 Watts (40' Max)	**1-40FT (2WDC)**	**20K**	2000K Sunset White	**27D**	2700K Warm Dim (5W Only)	**40K** 4000K Cool White
		5WDC	4.4 Watts (20' Max)	**1-20FT (5WDC)**	**22K**	2200K Candle White	**30K**	3000K Warm White	**57K** 5700K Daylight White
		7WDC	7.5 Watts (12' Max)	**1-12FT (7WDC)**	**24K**	2400K Very Warm White	**30D**	3000K Warm Dim (5W Only)	**2K6K** Tunable White 2000K-6500K
					27K	2700K Incandescent White	**35K**	3500K Neutral White	**27K6** Tunable White 2700K-6500K

PROJECT		FIXTURE TYPE		DATE	

VERGE WALL 24VDC

24VDC PLASTER-IN LED SYSTEM

REV 10.06.21

LUMEN DATA Lumen Data for Verge Ceiling 24VDC Clear Lens

CLEAR FROSTED LENS																							
WATTS PER FOOT	2W (2.5 watts)							5W (4.4 watts)									7W (7.5 watts)						
COLOR TEMPERATURE	22K	24K	27K	30K	35K	40K	57K	22K	24K	27K	27D*	30K	30D*	35K	40K	57K	22K	24K	27K	30K	35K	40K	57K
LUMENS PER FOOT (lm/ft)	106	106	108	112	129	136	143	197	197	199	207	207	211	238	251	265	304	304	307	320	368	387	409
LUMENS PER WATT (lm/w)	43	43	43	45	52	54	57	45	45	45	43	47	44	54	57	60	42	42	42	44	50	53	56
CRI	92+	92+	92+	92+	92+	92+	92+	92+	92+	92+	94+	92+	94+	92+	92+	92+	92+	92+	92+	92+	92+	92+	92+

*27D, 30D - Warm Dim (4.8 Watts)

	CLEAR FROSTED LENS																								
WATTS PER FOOT	**2K6K** 2W (2.5 watts)									**27K6** 2W (2.5 watts)							**2K6K** 5W (4.4 watts)								
COLOR TEMPERATURE	20K	22K	24K	27K	30K	35K	40K	57K	65K	27K	30K	35K	40K	45K	57K	65K	20K	22K	24K	27K	30K	35K	40K	57K	65K
LUMENS PER FOOT (lm/ft)	57	58	58	59	60	62	67	73	78	62	73	75	77	84	91	86	138	143	149	155	160	171	184	186	187
LUMENS PER WATT (lm/w)	31	29	29	30	30	31	90	36	43	34	37	38	39	42	45	48	30	30	31	32	33	36	38	39	41
CRI	91+	91+	91+	91+	91+	94+	94+	94+	91+	91+	91+	91+	94+	94+	94+	91+	91+	91+	91+	91+	91+	94+	94+	94+	91+

	CLEAR FROSTED LENS																						
WATTS PER FOOT	**27K6** 5W (4.4 watts)							**2K6K** 7W (7.5 watts)									**27K6** 7W (7.5 watts)						
COLOR TEMPERATURE	27K	30K	35K	40K	45K	57K	65K	20K	22K	24K	27K	30K	35K	40K	57K	65K	27K	30K	35K	40K	45K	57K	65K
LUMENS PER FOOT (lm/ft)	154	157	163	169	167	166	165	192	201	210	219	228	246	259	261	264	208	212	220	228	226	224	223
LUMENS PER WATT (lm/w)	38	34	35	37	36	36	41	30	28	29	30	32	34	36	36	41	32	30	31	32	31	31	35
CRI	91+	91+	91+	94+	94+	94+	91+	91+	91+	91+	91+	91+	94+	94+	94+	91+	92+	92+	92+	95+	93+	93+	93+

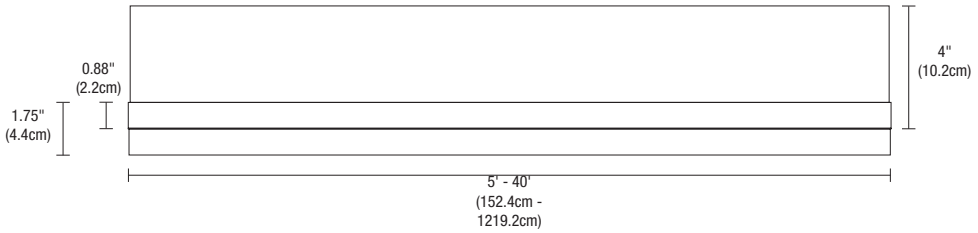
LUMEN DATA Lumen Data for Verge Ceiling 24VDC DIffused Lens

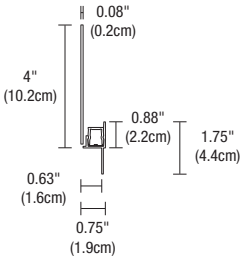
DIFFUSED LENS																							
WATTS PER FOOT	2W (2.5 watts)							5W (4.4 watts)									7W (7.5 watts)						
COLOR TEMPERATURE	22K	24K	27K	30K	35K	40K	57K	22K	24K	27K	27D*	30K	30D*	35K	40K	57K	22K	24K	27K	30K	35K	40K	57K
LUMENS PER FOOT (lm/ft)	102	102	103	108	124	130	138	189	189	191	199	199	203	229	241	255	292	292	295	307	354	372	394
LUMENS PER WATT (lm/w)	41	41	41	43	50	52	55	43	43	43	41	45	42	52	55	58	40	40	40	42	48	51	54
CRI	92+	92+	92+	92+	92+	92+	92+	92+	92+	92+	94+	92+	94+	92+	92+	92+	92+	92+	92+	92+	92+	92+	92+

*27D, 30D - Warm Dim (4.8 Watts)

	DIFFUSED LENS																								
WATTS PER FOOT	**2K6K** 2W (2.5 watts)									**27K6** 2W (2.5 watts)							**2K6K** 5W (4.4 watts)								
COLOR TEMPERATURE	20K	22K	24K	27K	30K	35K	40K	57K	65K	27K	30K	35K	40K	45K	57K	65K	20K	22K	24K	27K	30K	35K	40K	57K	65K
LUMENS PER FOOT (lm/ft)	57	58	58	59	60	62	67	73	78	59	70	72	74	81	87	83	138	143	149	155	160	171	184	186	187
LUMENS PER WATT (lm/w)	31	29	29	30	30	31	90	36	43	33	35	36	37	41	44	46	30	30	31	32	33	36	38	39	41
CRI	91+	91+	91+	91+	91+	94+	94+	94+	91+	91+	91+	91+	94+	94+	94+	91+	91+	91+	91+	91+	91+	94+	94+	94+	91+

	DIFFUSED LENS																								
WATTS PER FOOT	**27K6** 5W (4.4 watts)							**2K6K** 7W (7.5 watts)									**27K6** 7W (7.5 watts)						
COLOR TEMPERATURE	27K	30K	35K	40K	45K	57K	65K	20K	22K	24K	27K	30K	35K	40K	57K	65K	27K	30K	35K	40K	45K	57K	65K
LUMENS PER FOOT (lm/ft)	148	151	157	163	161	160	159	192	201	210	219	228	246	259	261	264	200	204	212	220	217	215	215
LUMENS PER WATT (lm/w)	37	33	34	35	35	35	40	30	28	29	30	32	34	36	36	41	31	28	29	30	30	30	34
CRI	91+	91+	91+	94+	94+	94+	91+	91+	91+	91+	91+	91+	94+	94+	94+	91+	92+	92+	92+	95+	93+	93+	93+





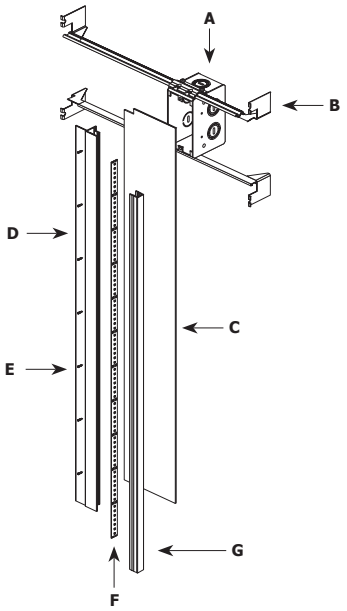
PROJECT		FIXTURE TYPE		DATE	

VERGE WALL 24VDC

24VDC PLASTER-IN LED SYSTEM

REV 10.06.21

INCLUDED COMPONENTS



A. JUNCTION BOX
Mounts behind drywall with Adjustable Mounting Bars. Low Voltage 24VDC wires from Remote Power Supply connect to LED wires inside box. Junction Box opening is covered by the Backer Plate and required at the beginning of each run.

B. ADJUSTABLE MOUNTING BARS
Provide flexibility for mounting in a variety of spaces.

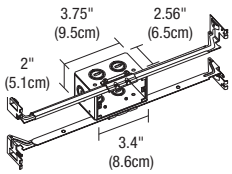
C. BACKER PLATE
4" paintable aluminum plate that conceals Junction Box and reflects light.

D. VERGE CHANNEL
5/8" deep extrusion houses a single row of LED Soft Strip

E. DRYWALL SCREWS
Secures channel to drywall and stud.

F. LED SOFT STRIP
Commercial-grade White or Dynamic Color Changing LED Soft Strip. See lamp data on for additional details.

G. LENS
0.6" wide diffuser lens projects a clean line of light without LED dots.



JUNCTION BOX ROUGH-IN COMPONENT

One Junction Box is included with Verge Wall. Order additional Junction Box(es) separately to rough-in electrical wiring before drywall installation. Quick shipment available.

System		Size		Component
VG	–	1RE	–	JBOX
VG Verge Wall		**1RE** 1" Rectangle		**JBOX** Junction Box

*For RGB+W use VG-1RE-JBOX-RGBW

2.5 WATTS PER FOOT 22K, 27K, 30K, 35K, 40K AND 57K WHITE LEDS

LENGTH IN FEET	WATTS	LENGTH IN FEET	WATTS
1	3	21	51
2	5	22	54
3	8	23	56
4	10	24	58
5	13	25	61
6	15	26	63
7	17	27	66
8	20	28	68
9	22	29	70
10	25	30	73
11	27	31	75
12	29	32	78
13	32	33	80
14	34	34	82
15	37	35	85
16	39	36	87
17	41	37	90
18	44	38	92
19	46	39	94
20	48	40	96

5 WATTS PER FOOT 22K, 27K, 27D, 30K, 30D, 35K, 40K AND 57K WHITE LEDS

LENGTH IN FEET	WATTS
1	5
2	10
3	14
4	19
5	24
6	29
7	34
8	38
9	43
10	48
11	53
12	58
13	63
14	67
15	72
16	77
17	82
18	87
19	91
20	96

3 WATTS PER FOOT RGB LEDS

LENGTH IN FEET	WATTS	LENGTH IN FEET	WATTS
1	3	21	55
2	6	22	58
3	8	23	60
4	11	24	63
5	13	25	65
6	16	26	68
7	19	27	71
8	21	28	73
9	24	29	76
10	26	30	78
11	29	31	81
12	32	32	84
13	34	33	86
14	37	34	89
15	39	35	91
16	42		
17	45		
18	47		
19	50		
20	52		

6 WATTS PER FOOT RGB+W LEDS

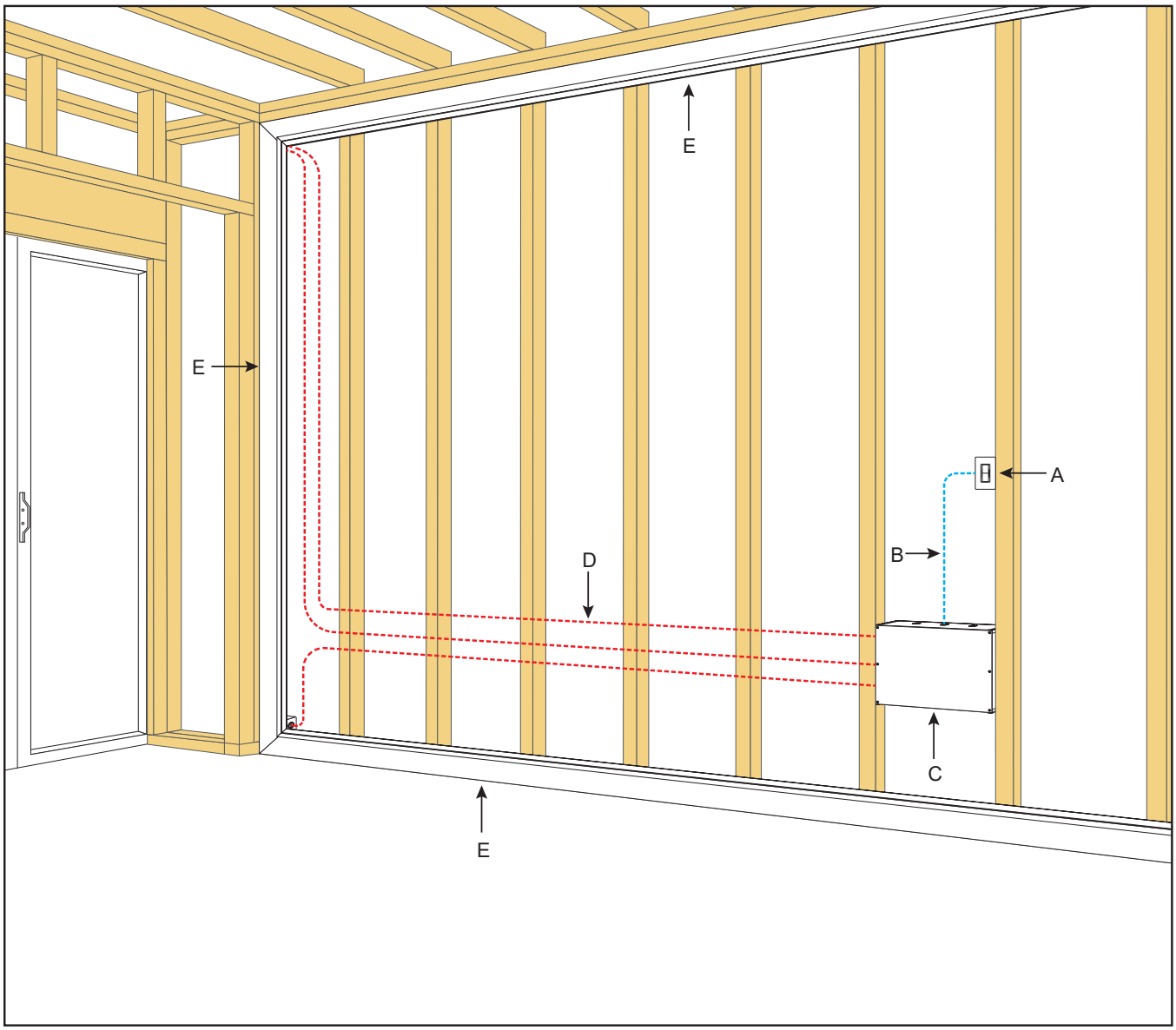
LENGTH IN FEET	WATTS
1	6
2	12
3	18
4	24
5	30
6	36
7	42
8	48
9	54
10	60
11	66
12	72
13	78
14	84
15	90
16	96

5 WATTS PER FOOT 2K6K TUNABLE WHITE LEDS

LENGTH IN FEET	2K WATTS	6K WATTS
1	3	3
2	5	5
3	8	8
4	10	10
5	12	12
6	15	15
7	17	17
8	20	20
9	22	22
10	24	24
11	27	27
12	29	29
13	32	32
14	34	34
15	36	36
16	39	39
17	41	41
18	44	44
19	46	46
20	48	48

PROJECT		FIXTURE TYPE		DATE	

INSTALLATION



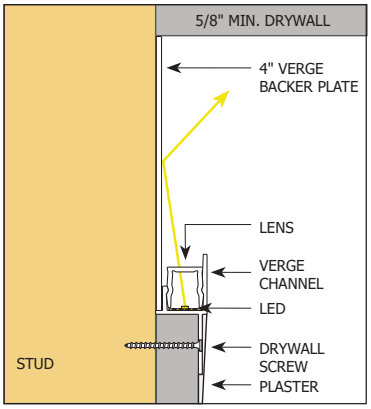
A. DIMMER OR SWITCH

B. 120VAC WIRING

C. 120V/24VDC REMOTE POWER SUPPLY FOR IN-WALL MOUNTING KIT

D. 24VDC, CLASS 2 WIRING

E. VERGE WALL CHANNEL



Direction of Light Cove Installation

PROJECT		FIXTURE TYPE		DATE	

INDOOR CONSTANT VOLTAGE 0-10V REMOTE POWER SUPPLIES

24VDC, 0-10V FOR STATIC WHITE, WARM DIM

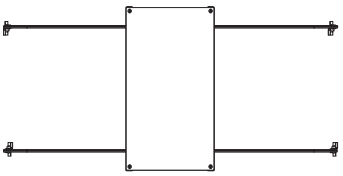
REV 10.06.21

0-10 VOLT (010) POWER SUPPLIES & RECOMMENDED DIMMERS			
ORDERING CODE	**PSB-25W-010-24VDC**	**PSB-60W-010-24VDC**	**PSB-96W-010-24VDC**
SPECIFICATIONS			
MAXIMUM LOAD	25W	60W	96W
INPUT VOLTAGE	120-277VAC	120-277VAC	120-277VAC
OUTPUT VOLTAGE	24VDC	24VDC	24VDC
DIMENSIONS	12.4" X 3.12" X 2.18"	12.4" X 3.12" X 2.18"	12.4" X 3.12" X 2.18"
CLASSIFICATION	CLASS 2	CLASS 2	CLASS 2
T-BAR MOUNTING	**PSB-25W-010-24VDC-TB**	**PSB-60W-010-24VDC-TB**	**PSB-96W-010-24VDC-TB**
IN-WALL MOUNTING	**PSB-25W-010-24VDC-IW**	**PSB-60W-010-24VDC-IW**	**PSB-96W-010-24VDC-IW**

0-10 VOLT (010) POWER SUPPLIES & RECOMMENDED DIMMERS			
ORDERING CODE	**PSB-2X96W-010-24VDC**	**PSB-3X96W-010-24VDC**	**PSB-4X96W-010-24VDC**
SPECIFICATION			
MAXIMUM LOAD	2X96W	3X96W	4X96W
INPUT VOLTAGE	120-277VAC	120-277VAC	120-277VAC
OUTPUT VOLTAGE	24VDC	24VDC	24VDC
DIMENSIONS	12.15" X 6.48" X 2.18"	14" X 10" X 3"	17" X 13" X 3"
CLASSIFICATION	CLASS 2	CLASS 2	CLASS 2
T-BAR MOUNTING	**PSB-2X96W-010-24VDC-TB**	**PSB-3X96W-010-24VDC-TB**	**PSB-4X96W-010-24VDC-TB**
IN-WALL MOUNTING	**PSB-2X96W-010-24VDC-IW**	N/A	N/A
DIMMING & CONTROLS			
PHILIPS SUNRISE: SR1200ZTUNV	•	•	•
LUTRON DIVA: DVTV-WH, DVSTV-WH	•	•	•
LUTRON NOVA T: NTSTV-DV-XX	•	•	•
LUTRON GRAFIX EYE QS: QSGRJ-XP	•	•	•
LUTRON RADIO RA2: RRD-10ND	•	•	•
LEVITON: LEV40050	•	•	•
LEVITON IP710-LFZ	•	•	•
LEGRAND: ADPD4FBL3P2W4	•	•	•

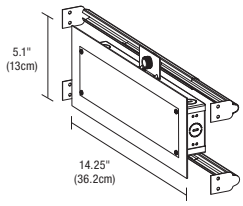
- Flicker free dimming
- Aluminum casing for optimal heat dissipation
- Isolated output power per NEC and UL safety requirements
- UL & ETL recognized/ listed, meets UL 8750, 1310 requirements
- Auto-reset; short circuit, overload and thermal protection
- Class 2 power supply
- Efficient, High power factor > 90

*Title 24 compliant when used with JA8 listed PureEdge systems.
**Up + Down Light fixtures and Systems can be controlled individually or together depending on the power supply selection.



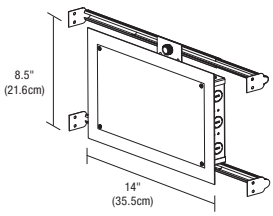
T-BAR Mounting Kit: Includes power supply, box cover, and T-bar hangers for installing Junction Box above ceiling with in easy reach. Comes with 4' of 14 gauge pair Teflon cables with quick secure connectors.

Ordering Codes:
PSB-25W-010-24VDC-TB,
PSB-60W-010-24VDC-TB,
PSB-96W-010-24VDC-TB,
PSB-2X96W-010-24VDC-TB
PSB-3X96W-010-24VDC-TB
PSB-4X96W-010-24VDC-TB



5.1" x 14.25" In-Wall Mounting Kit: Includes power supply, box cover and stud hangers for installing Junction Box in wall. Select "IW" in the options section of compatible power supply ordering codes if an In-Wall Mounting Kit is needed.

Ordering Codes: PSB-25W-010-24VDC-IW, PSB-60W-010-24VDC-IW, PSB-96W-010-24VDC-IW



8.5" x 14" In-Wall Mounting Kit: Includes power supply, box cover and stud hangers for installing Junction Box in wall. Select "IW" in the options section of compatible power supply ordering codes if an In-Wall Mounting Kit is needed.

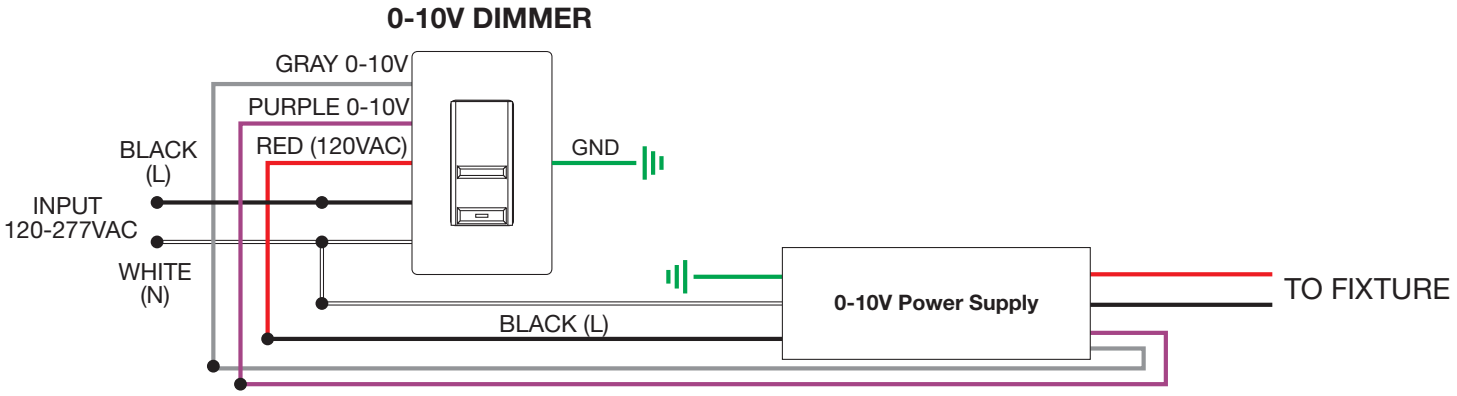
Ordering Codes: PSB-2X96W-010-24VDC-IW

PROJECT		FIXTURE TYPE		DATE	

SAMPLE WIRING DIAGRAMS 24VDC 010

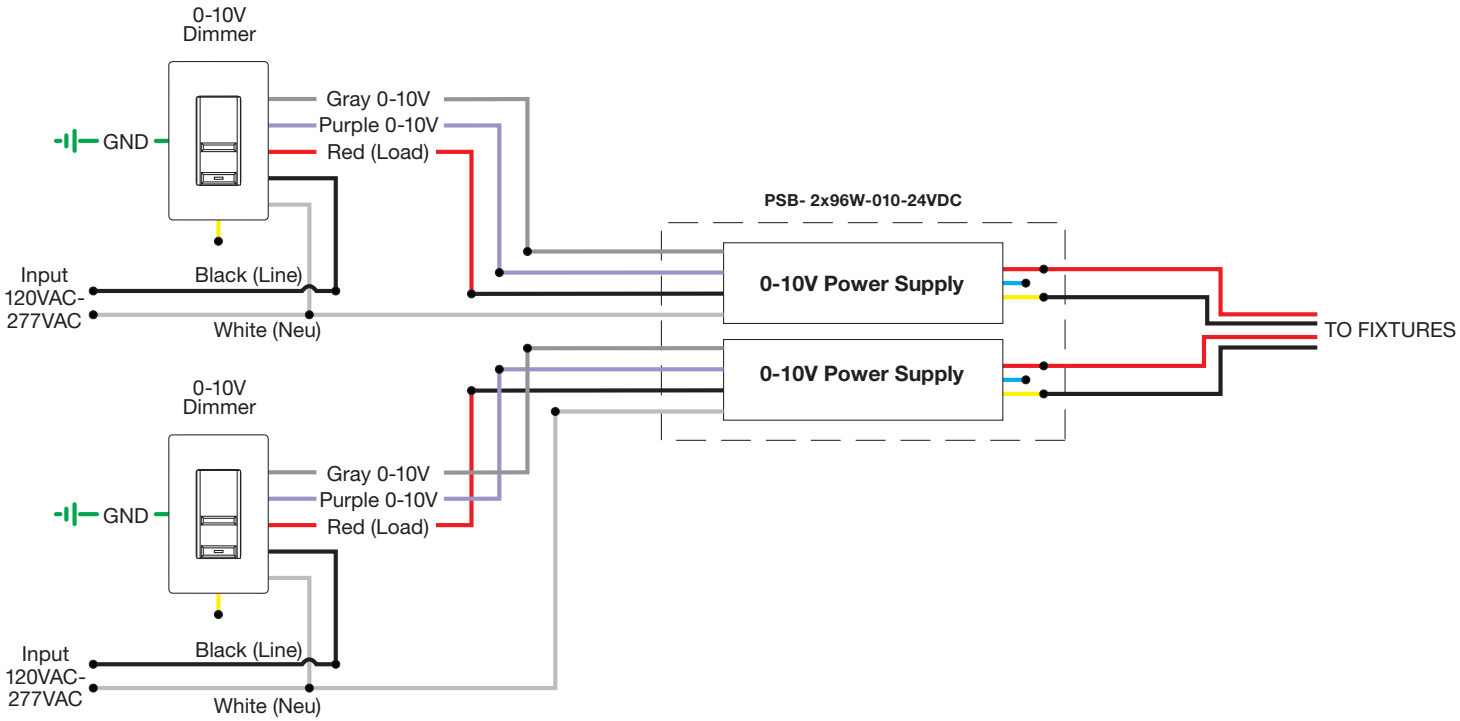
Application: 0-10V Dimming Applications For Static White and Warm Dim

Dimming: Dimmable with 0-10V dimmers: Signify (Phillips) Sunrise: SR1200ZTUNV, Leviton Dimmers: LEV40050, IP710-LFZ, *IP710-DLZ *(Built in LED locator light) Legrand Dimmer: ADPD4FBL3P2W4 Lutron Systems: Lutron GRAFIX Eye QS Main Unit (with DRX-TVI) Radio Ra2 (with GRX-TVI)



Application: Dual 0-10V dimming for Static White

Dimming: Dimmable with Dual 0-10V dimmers: Signify (Phillips) Sunrise: SR1200ZTUNV, Leviton Dimmers: LEV40050, IP710-LFZ, *IP710-DLZ *(Built in LED locator light), Legrand Dimmer: ADPD4FBL3P2W4, Lutron Systems: Lutron GRAFIX Eye QS Main Unit (with DRX-TVI) Radio Ra2 (with GRX-TVI)



PROJECT		FIXTURE TYPE		DATE	

INDOOR CONSTANT VOLTAGE REMOTE POWER SUPPLIES

24VDC, ELECTRONIC LOW VOLTAGE FOR STATIC WHITE, WARM DIM

REV 10.06.21

	ELECTRONIC LOW-VOLTAGE (ELV) POWER SUPPLIES & RECOMMENDED DIMMERS†‡			
ORDERING CODES	**PS-60L-ELV-24VDC**	**PSB-60W-ELV-24VDC**	**PSB-2X60W-ELV-24VDC**	**PSB-100W-ELV-24VDC**
	SPECIFICATIONS			
MAXIMUM LOAD	60W NON-IC, 50W-IC (FITS IN JBOX)	60W	2X60W	96W
INPUT VOLTAGE	120VAC	120VAC	120VAC	120VAC
OUTPUT VOLTAGE	24VDC	24VDC	24VDC	24VDC
DIMENSIONS	2.25" X 1.25" X 0.83"	8.125" X 2" X 1.75"	12.15" X 6.48" X 2.18"	9.25" X 3.5" X 2"
CLASSIFICATION	CLASS 2	CLASS 2	CLASS 2	CLASS 2
T-BAR MOUNTING	N/A	**PSB-60W-ELV-24VDC-TB**	**PSB-2X60W-ELV-24VDC-TB**	**PSB-100W-ELV-24VDC-TB**
IN WALL MOUNTING	N/A	**PSB-60W-ELV-24VDC-IW**	**PSB-2X60W-ELV-24VDC-IW**	**PSB-100W-ELV-24VDC-IW**

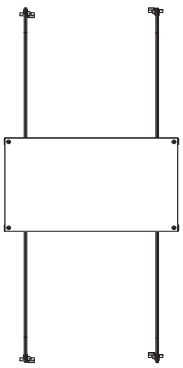
	ELECTRONIC LOW-VOLTAGE (ELV) POWER SUPPLIES & RECOMMENDED DIMMERS†‡		
ORDERING CODES	**PSB-2X100W-ELV-24VDC**	**PSB-3X100W-ELV-24VDC**	**PSB-4X100W-ELV-24VDC**
	SPECIFICATIONS		
MAXIMUM LOAD	2X96W	3X96W	4X96W
INPUT VOLTAGE	120VAC	120VAC	120VAC
OUTPUT VOLTAGE	24VDC	24VDC	24VDC
DIMENSIONS	12.15" X 6.48" X 2.18"	14" X 10" X 3"	17" X 13" X 3"
CLASSIFICATION	CLASS 2	CLASS 2	CLASS 2
T-BAR MOUNTING	**PSB-2X100W-ELV-24VDC-TB**	**PSB-3X100W-ELV-24VDC-TB**	**PSB-4X100W-ELV-24VDC-TB**
IN WALL MOUNTING	**PSB-2X100W-ELV-24VDC-IW**	N/A	N/A
	DIMMING AND CONTROLS		
LUTRON DIVA: DVELV-300P	•	•	•
LUTRON SKYLARK: SELV-300P	•	•	•
LUTRON RADIO RA2: RRD-6NA	•	•	•
LUTRON MAESTRO: MAELV-600	•	•	•
LEGRAND ADORNE: ADTP-703TUM4	•	•	•

†22K - 57K color temperatures are compatible with 0-10V, ELV, and Lutron Hi-Lume® Power Supplies. Warm Dim (27D, 30D) color temperatures are only compatible with ELV power supplies. Tunable White color temperature is compatible with 0-10V, ELV, DMX, and Lutron Hi-Lume® Power Supplies. Color (RGB, RGB+W) and Static Color (Amber, Blue, Green, or Red) are compatible with DMX Power Supplies.

‡Electrical Panels using Seimens/Murray AFCI breakers are not compatible with this ELV transformer. Use 0-10 Volt power supplies with this breaker

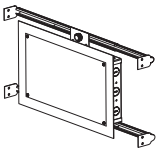
With N-Lite Dimming Do Not use ELV power supplies, use only 0-10 volt or Uni drivers power supplies

**Up + Down Light fixtures and Systems can be controlled individually or together depending on the power supply selection.



T-BAR Mounting Kit: Includes power supply, box cover, and T-bar hangers for installing Junction Box above ceiling with in easy reach. Comes with 4' of 14 gauge pair Teflon cables with quick secure connectors.

Ordering Codes : PSB-60W-ELV-24VDC-TB
PSB-100W-ELV-24VDC-TB
PSB-2X60W-ELV-24VDC-TB
PSB-2X100W-ELV-24VDC-TB
PSB-3X100W-ELV-24VDC-TB
PSB-4X100W-ELV-24VDC-TB



In-Wall Mounting Kit: Includes power supply, box cover and stud hangers for installing Junction Box in wall. Select "IW" in the options section of compatible power supply ordering codes if an In-Wall Mounting Kit is needed.

Ordering Codes 5.1" x 14.25": PSB-60W-ELV-24VDC-IW
PSB-100W-ELV-24VDC-IW

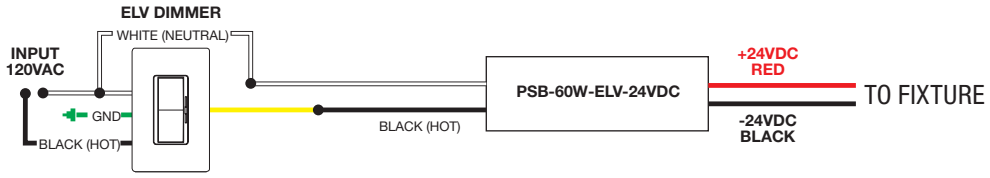
Ordering Codes 8.5" x 14.25": PSB-2X60W-ELV-24VDC-IW
PSB-2X100W-ELV-24VDC-IW

PROJECT		FIXTURE TYPE		DATE	

SAMPLE WIRING DIAGRAMS 24VDC ELV

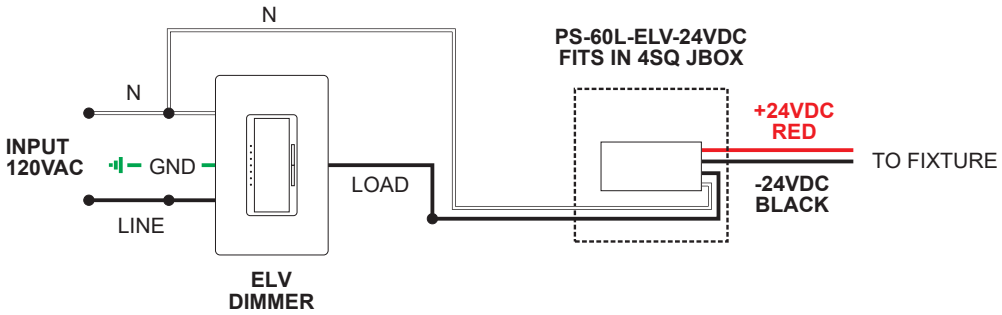
Application: ELV dimming for Static White

Dimming: Dimmable with ELV dimmer: Legrand, Adorne ADTP703TU; Lutron: Diva DVELV-300P, Skylark SELV-300P, Maestro MAELV-600 and Radio Ra 2



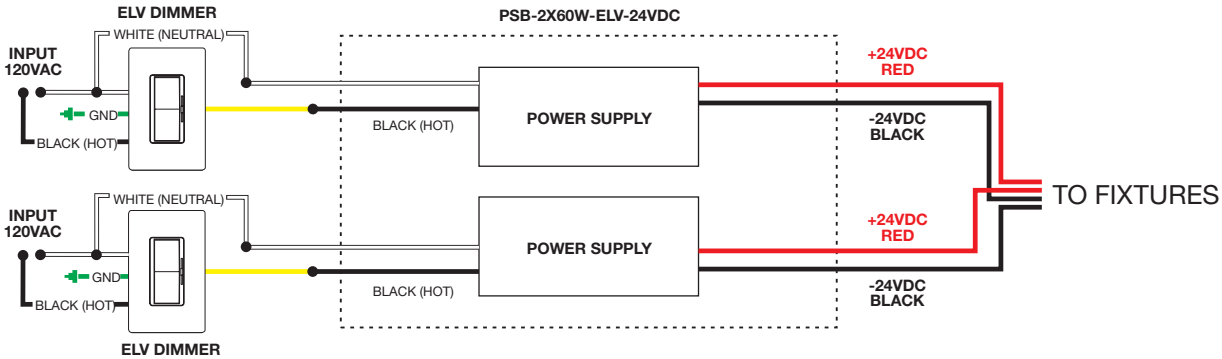
Application: ELV dimming for Static White

Dimming: Dimmable with ELV dimmer: Legrand, Adorne ADTP703TU; Lutron: Diva DVELV-300P, Skylark SELV-300P, Maestro MAELV-600 and Radio Ra 2



Application: Dual ELV dimming for Static White

Dimming: Dimmable with ELV dimmer: Legrand, Adorne ADTP703TU; Lutron: Diva DVELV-300P, Skylark SELV-300P, Maestro MAELV-600 and Radio Ra 2



PROJECT		FIXTURE TYPE		DATE	

INDOOR CONSTANT VOLTAGE REMOTE POWER SUPPLIES

24VDC, UNIVERSAL DIMMING WITH ELV, TRIAC, & 0-10V FOR STATIC WHITE, WARM DIM

REV 10.06.21

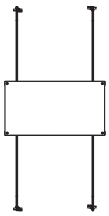
UNIVERSAL POWER SUPPLIES & RECOMMENDED DIMMERS				
ORDERING CODE	**PSB-40W-UNI-24VDC**	**PSB-60W-UNI-24VDC**	**PSB-2X40W-UNI-24VDC**	**PSB-2X60W-UNI-24VDC**
SPECIFICATIONS				
MAXIMUM LOAD	40W	60W	2X40W	2X60W
INPUT VOLTAGE	120-277VAC	120-277VAC	120-277VAC	120-277VAC
OUTPUT VOLTAGE	24VDC	24VDC	24VDC	24VDC
DIMENSIONS	12.4" X 3.12" X 2.18"	12.4" X 3.12" X 2.18"	12.15" X 6.48" X 2.18"	12.15" X 6.48" X 2.18"
CLASSIFICATION	CLASS 2	CLASS 2	CLASS 2	CLASS 2
T-BAR MOUNTING	**PSB-40W-UNI-24VDC-TB**	**PSB-60W-UNI-24VDC-TB**	**PSB-2X40W-UNI-24VDC-TB**	**PSB-2X60W-UNI-24VDC-TB**
IN-WALL MOUNTING	**PSB-40W-UNI-24VDC-IW**	**PSB-60W-UNI-24VDC-IW**	**PSB-2X40W-UNI-24VDC-IW**	**PSB-2X60W-UNI-24VDC-IW**
UNIVERSAL POWER SUPPLIES & RECOMMENDED DIMMERS				
ORDERING CODE	**PSB-96W-UNI-24VDC**	**PSB-2X96W-UNI-24VDC**	**PSB-3X96W-UNI-24VDC**	**PSB-4X96W-UNI-24VDC**
SPECIFICATIONS				
MAXIMUM LOAD	96W	2X96W	3X96W	4X96W
INPUT VOLTAGE	120-277VAC	120-277VAC	120-277VAC	120-277VAC
OUTPUT VOLTAGE	24VDC	24VDC	24VDC	24VDC
DIMENSIONS	12.4" X 3.12" X 2.18"	12.15" X 6.48" X 2.18"	14" X 10" X 3"	17" X 13" X 3"
CLASSIFICATION	CLASS 2	CLASS 2	CLASS 2	CLASS 2
T-BAR MOUNTING	**PSB-96W-UNI-24VDC-TB**	**PSB-2X96W-UNI-24VDC-TB**	**PSB-3X96W-UNI-24VDC-TB**	**PSB-4X96W-UNI-24VDC-TB**
IN-WALL MOUNTING	**PSB-96W-UNI-24VDC-IW**	**PSB-2X96W-UNI-24VDC-IW**	NA	NA
ELV DIMMING & CONTROLS				
LUTRON DIVA: DVELV-300P	•	•	•	•
LUTRON SKYLARK: SELV-300P	•	•	•	•
LUTRON RADIO RA2: RRD-6NA	•	•	•	•
LUTRON MAESTRO: MAELV-600	•	•	•	•
LEGRAND ADORNE: ADTP-703TUM4	•	•	•	•
0-10 DIMMING & CONTROLS				
PHILIPS SUNRISE: SR1200ZTUNV	•	•	•	•
LUTRON DIVA: DVTV-WH, DVSTV-WH	•	•	•	•
LUTRON NOVA T: NTSTV-DV-XX	•	•	•	•
LUTRON GRAFIX EYE QS: QSGRJ-XP	•	•	•	•
LUTRON RADIO RA2: RRD-10ND	•	•	•	•
LEVITON: LEV40050	•	•	•	•
LEVITON IP710-LFZ	•	•	•	•
LEGRAND: ADPD4FBL3P2W4	•	•	•	•
TRIAC DIMMING & CONTROLS				
LUTRON SKYLARK: S2-L-WH	•	•	•	•
LUTRON DIVA DVLV-600P-WH	•	•	•	•
LUTRON DIVA DVLV-603P-WH	•	•	•	•
LUTRON MAESTRO MALV-600-WH	•	•	•	•
LUTRON MAESTRO MALV-1000-WH	•	•	•	•
LUTRON MAESTRO MA-R-XX	•	•	•	•

- Flicker free dimming
- Aluminum casing for optimal heat dissipation
- Isolated output power per NEC and UL safety requirements
- UL & ETL recognized/ listed, meets UL 8750, 1310 requirements
- Auto-reset; short circuit, overload and thermal protection
- Class 2 power supply
- Efficient, High power factor > 0.90

- The Solid State Constant Voltage Uni-Power Supply is compatible with most commercially available Dimmers:
  - Triac Dimmer: (Forward Phase) Typically used for the dimming of Incandescent and Low Voltage Magnetic Transformers
  - ELV Dimmer: (Reverse Phase) Dimming of Electronic Low Voltage Transformers and Power Supplies used for LED lighting
  - 0-10 Dimmer : Dims the Low Voltage side of a 0-10 volt power supply commonly used in large scale lighting or commercial applications.
- The Uni-Power Supply is recommended with any Siemens/Murray brand of arc fault breaker to overcome the issues with tripping the breakers with an ELV LED Low Voltage Drivers.

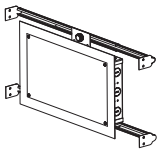
*Title 24 with JA8 listed PureEdge products and systems

*Tunable White requires Dual power Supplies and Controls. For single control use with our proprietary Tunable White Controller CDMX-1, refer to Universal Tunable White Power Supply Specifications. Up + Down Light fixtures and Systems can be controlled individually or together depending on the power supply selection.



T-BAR Mounting Kit: Includes power supply, box cover, and T-bar hangers for installing Junction Box above ceiling with in easy reach. Comes with 4' of 14 gauge pair Teflon cables with quick secure connectors.

Ordering Codes : PSB-40W-UNI-24VDC-TB, PSB-60W-UNI-24VDC-TB, PSB-96W-UNI-24VDC-TB, PSB-2X40W-UNI-24VDC-TB, PSB-2X60W-UNI-24VDC-TB, PSB-2X96W-UNI-24VDC-TB, PSB-3X96W-UNI-24VDC-TB, PSB-4X96W-UNI-24VDC-TB



In-Wall Mounting Kit: Includes power supply, box cover and stud hangers for installing Junction Box in wall. Select "IW" in the options section of compatible power supply ordering codes if an In-Wall Mounting Kit is needed.

Ordering Codes 5.1" x 14.25": PSB-40W-UNI-24VDC-IW, PSB-60W-UNI-24VDC-IW, PSB-96W-UNI-24VDC-IW

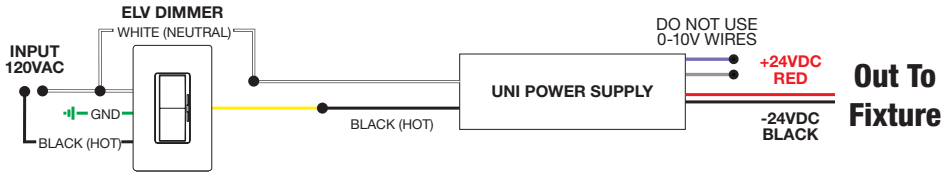
Ordering Codes 8.5" x 14.25": PSB-2X40W-UNI-24VDC-IW, PSB-2X60W-UNI-24VDC-IW, PSB-2X96W-UNI-24VDC-IW

PROJECT		FIXTURE TYPE		DATE	

WIRING DIAGRAMS UNIVERSAL POWER SUPPLY

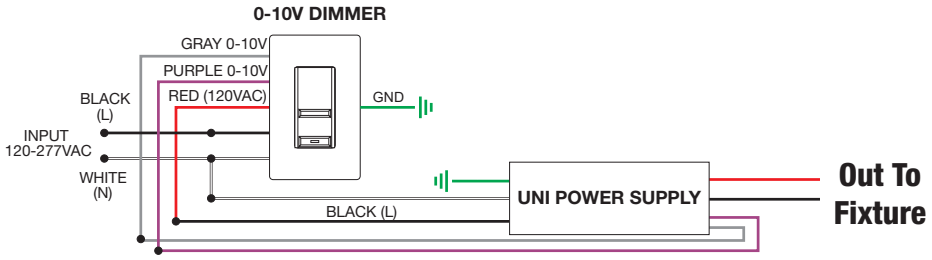
Application: ELV dimming for Static White and Warm Dim

Dimming: Dimmable with ELV dimmer: Legrand, Adorne ADTP703TU; Lutron: Diva DVELV-300P, Skylark SELV-300P, Maestro MAELV-600 and Radio Ra 2



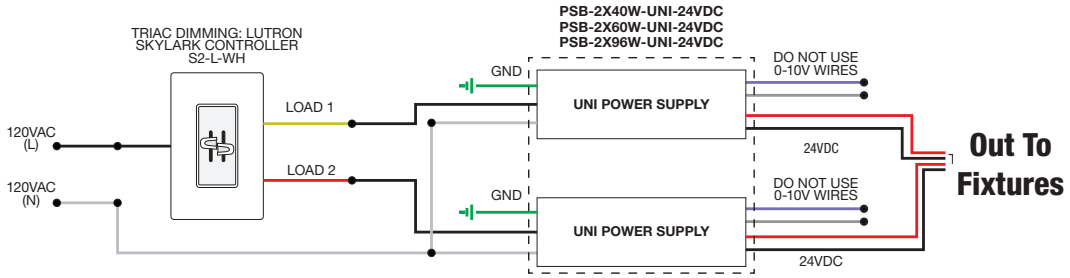
Application: 0-10V dimming for Static White

Dimming: Dimmable with 0-10V dimmer: Philips Sunrise: SR1200ZTUNV; Lutron Diva: DVTV-WH, DVSTV-WH; Lutron Nova T: NTSTV-DV-XX; Lutron Grafix EYE QS: QSGRJ-XP; Lutron Radio Ra2: RRD-10ND; Leviton: LEV40050; Leviton IP710-LFZ; Legrand: ADPD4FBL3P2W4



Application: Triac dimming for two power supplies, use for Static White

Dimming: Dimmable with Triac dimmer: Lutron: Skylark S2-L



PROJECT		FIXTURE TYPE		DATE	

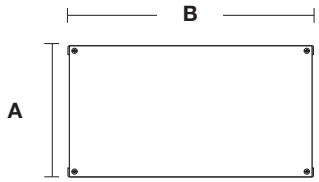
INDOOR TUNABLE WHITE 0-10V 96 WATT LED POWER SUPPLY

24VDC INDOOR CONSTANT VOLTAGE, TWO CHANNEL CONTROLS, FOR INTENSITY AND COLOR TEMPERATURE

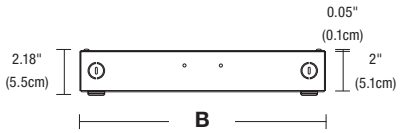
DESIGNED BY GREGORY KAY | ASSEMBLED IN AMERICA

REV 10.06.21

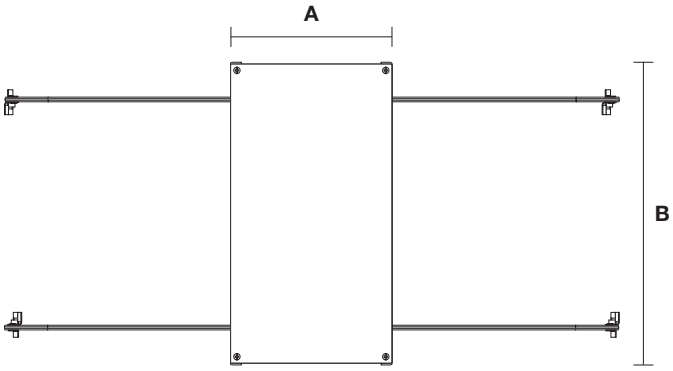
PSB-96W-010-24VDC-2XK



TOP VIEW



SIDE VIEW



PSB-96W-010-24VDC-2XK-TB
(T-BAR GRID CEILING)

STANDARD & T-BAR DIMENSIONS		
	A	B
PSB-96W-010-24VDC-2XK	6.48"	12.15"
PSB-2X96W-010-24VDC-2XK	10"	14"
PSB-3X96W-010-24VDC-2XK	13"	17"
PSB-4X96W-010-24VDC-2XK	13"	17"

DESCRIPTION

Accepts input voltage in a range of 120 - 277VAC and outputs 24VDC power up to 96 watts. The low voltage output dims down to 1% when two additional wires are connected to a 0-10V dimmer. The enclosure provides a space inside for electrical connections. In-Wall Power Supply Kit includes power supply, box cover and stud hangers. T-Bar Mounting Kit includes power supply, box cover, and T-bar hangers for installing Junction Box above ceiling with in easy reach. Comes with 4' of 14 gauge pair Teflon cables with quick secure connectors. Power Supply features short circuit, overload and over temperature protection.

APPLICATIONS

Indoor, Damp Location

MOUNTING

Surface mounted with conduit access

POWER INPUT

120-277VAC

POWER OUTPUT

Class 2; 24 volts DC 4A, up to 96 watts maximum

EFFICIENCY

90%

AMBIENT OPERATING TEMPERATURE

-25° C to 40° C

DIMMING

#1 Controls the intensity. #2 Controls the Color Temperature.
0-10V (dimmer needs to be capable to dim to 0% without ON/OFF switch)

DIMMING CURVE

Linear, Logarithmic 100% - 0% (HydraDrive)

COMPLIANCE

Made in the USA, UL, CE, Title 28, Plenum for use in Accordance with UL 2043.
*Title 24 with JA8 listed PureEdge products and systems

Product		Wattage		Dimming		Voltage		Color Temperature		Options
PSB	–	**96W**	–	**010**	–	**24VDC**	–	**2XK**	–	**STANDARD** (Leave Blank)

PSB Power Supply with Enclosure Box with Tunable White 0-10V Controller

96W 96 Watts
2X96W 2x96 Watts
3X96W 3x96 Watts
4X96W 4x96 Watts

010 0-10 Volt Dimming

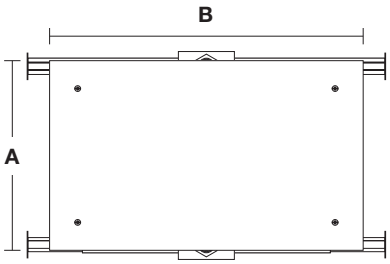
24VDC 24 Volt DC

2XK Tunable White

TB T-Bar Grid Ceiling
IW* In-Wall Kit

*96 watts only

PSB-96W-010-24VDC-2XK-IW



PSB-96W-010-24VDC-2XK-IW (IN WALL KIT)

IN-WALL DIMENSIONS		
	A	B
PSB-96W-010-24VDC-2XK-IW	8.5"	14.25"

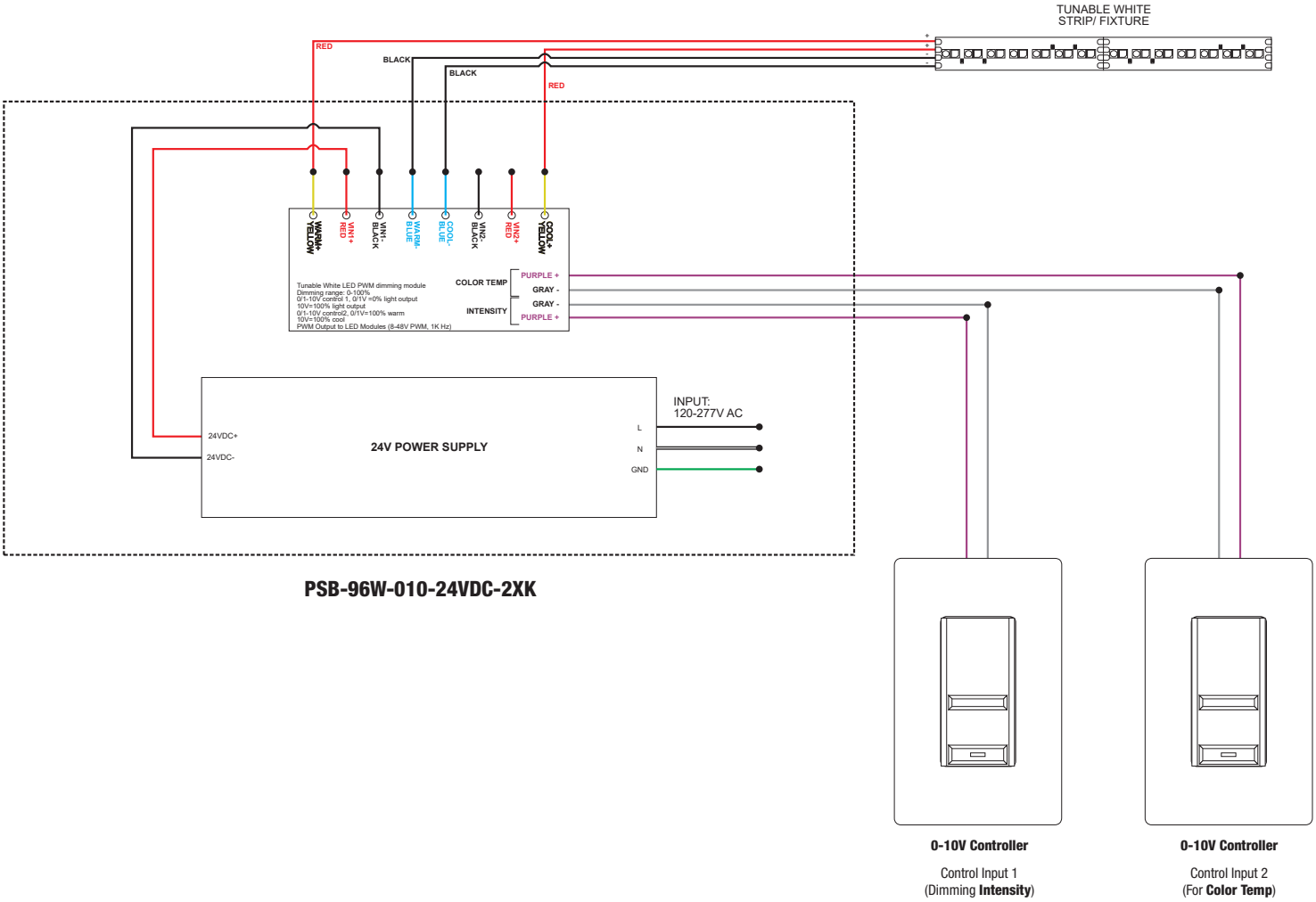
PROJECT		FIXTURE TYPE		DATE	

INDOOR TUNABLE WHITE 0-10V 96 WATT LED POWER SUPPLY

24VDC INDOOR CONSTANT VOLTAGE, TWO CHANNEL CONTROLS, FOR INTENSITY AND COLOR TEMPERATURE

REV 10.06.21

Application: 0-10V dimming for Tunable White LED Strip/Fixture



PSB-96W-010-24VDC-2XK

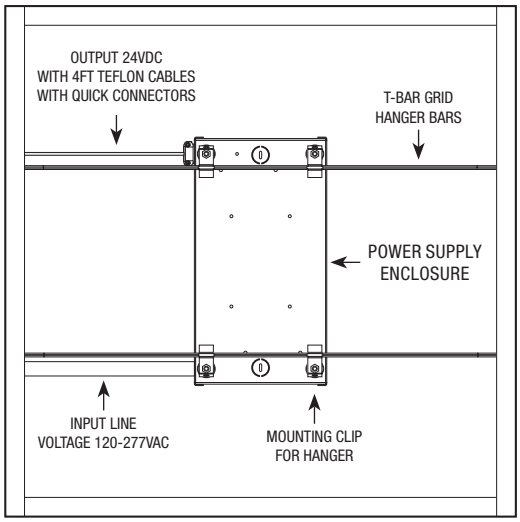
0-10V Controller

Control Input 1
(Dimming **Intensity**)

0-10V Controller

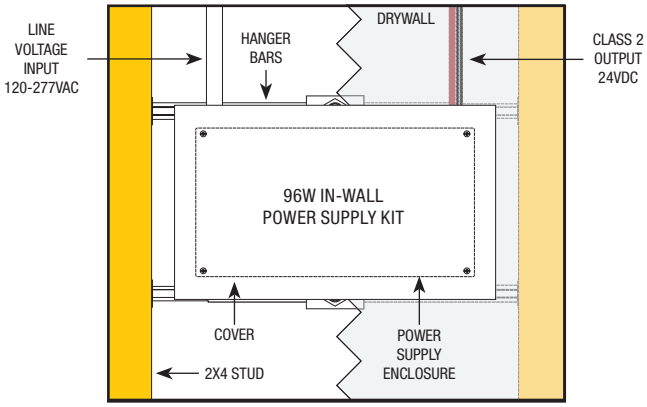
Control Input 2
(For **Color Temp**)

T-BAR GRID CEILING



PSB-96W-010-24VDC-2XK-TB

IN WALL KIT



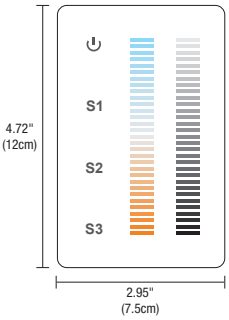
PSB-96W-010-24VDC-2XK-IW

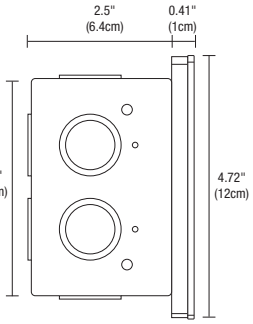
PROJECT		FIXTURE TYPE		DATE	

TUNABLE WHITE DMX CONTROLLER AND POWER SUPPLIES

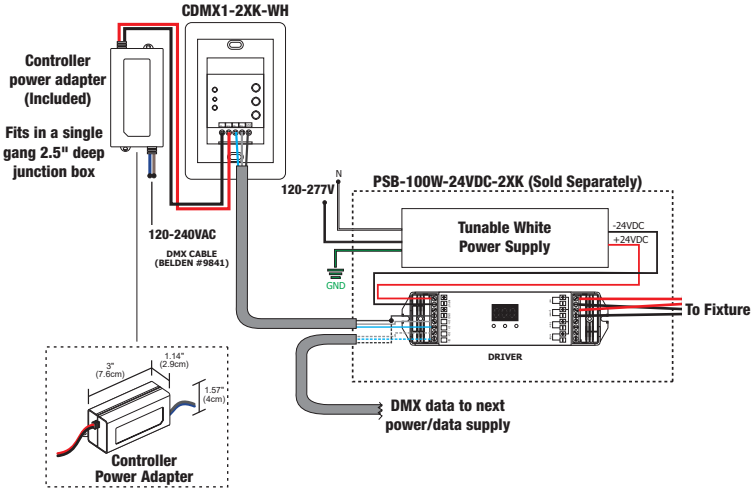
24VDC INDOOR CONSTANT VOLTAGE POWER SUPPLIES WITH DRIVERS

REV 10.06.21





Side View JBox



DESCRIPTION:

The Tunable White Touch Controller offers fast and accurate Color Temperature adjustment and the ability to regulate the Brightness Independently. The modern Glass faceplate features illuminated indicators, and a back-lit night light that softly illuminates the controller when powered off. Designed for Tunable White, and dual-color LED installations within a single zone. The two Vertical Touch sliders are precise and sensitive, allowing you to fine-tune your perfect Color Temperature at any point between **2000K** (Sunset) to **6500K** (Daylight White) while selecting over 250 levels of Brightness in a smooth, uninterrupted transition. Create Thousands of White Color Combinations while maintaining even Brightness and overall saturation. Easily save three pre-set scenes for different times of the day. Support health, performance, and general well-being using Human-Centric lighting by fine-tuning the biological effects that light has on the circadian cycle using the latest in LED technology. Includes a power adapter that fits behind the controller within a standard junction box and fits inside a standard single-gang receptacle (not for use in a multi-gang box). Use with an insulated, 24 AWG stranded, tinned copper wire (Belden #9841). Power Supplies are Sold Separately. Includes a 5 year pro-rated warranty.

APPLICATIONS:

Indoor

OUTPUT SIGNAL:

USITT DMX 512 (1990)

INSTALLATION:

Fits in a single gang 2.5" deep junction box. Not compatible with multi-gang boxes.

LABELS:

ROHS, FCC, Damp Location, ETL/UL

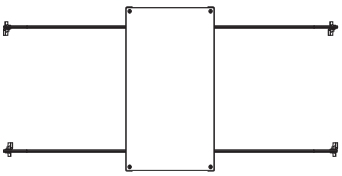
POWER INPUT:

120-240VAC

Product		Type		Finish
CDMX1	–	**2XK**	–	**WH**
CDMX1 DMX Single Zone Touch Controller		**2XK** Tunable White		**WH** White

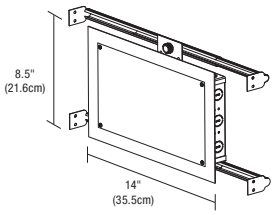
COLOR CHANGING (DMX) POWER SUPPLIES				
ORDERING CODE	**PSB-100W-24VDC-2XK**	**PSB-2X100W-24VDC-2XK**	**PSB-3X100W-24VDC-2XK**	**PSB-4X100W-24VDC-2XK**
SPECIFICATIONS				
MAXIMUM LOAD OF LED STRIP LENGTH	100W 5 WATTS - 20FT MAX. 10 WATTS - 10FT MAX.	2X100W 5 WATTS 2 X 20FT MAX. 10 WATTS - 2 X 10FT MAX.	3X100W 5 WATTS 3 X 20FT MAX. 10 WATTS - 3 X 10FT MAX.	4X100W 5 WATTS 4 X 20FT MAX. 10 WATTS - 4 X 10FT MAX.
INPUT VOLTAGE	120-277VAC	120-277VAC	120-277VAC	120-277VAC
OUTPUT VOLTAGE	24VDC	24VDC	24VDC	24VDC
DIMENSIONS	12.4" X 6.48" X 2.18"	14" X 10" X 3"	17" X 10" X 3"	17" X 10" X 3"
CLASSIFICATION	CLASS 2	CLASS 2	CLASS 2	CLASS 2
T-BAR MOUNTING	**PSB-100W-24VDC-2XK-TB**	**PSB-2X100W-24VDC-2XK-TB**	**PSB-3X100W-24VDC-2XK-TB**	**PSB-4X100W-24VDC-2XK-TB**
IN-WALL MOUNTING	**PSB-100W-24VDC-2XK-IW**	NA	NA	NA
DMX TUNABLE WHITE DIMMING & CONTROLS				
TUNABLE WHITE TOUCH CONTROLLER (CDMX1-2XK)	•	•	•	•

- Flicker free dimming
- Aluminum casing for optimal heat dissipation
- Isolated output power per NEC and UL safety requirements
- UL & ETL recognized/ listed, meets UL 8750, 1310 requirements
- Auto-reset; short circuit, overload and thermal protection
- Class 2 power supply
- Efficient, High power factor > 0.90



T-BAR Mounting Kit: Includes power supply, box cover, and T-bar hangers for installing Junction Box above ceiling with in easy reach. Comes with 4ft of 14 gauge pair Teflon cables with quick secure connectors.

Ordering Codes:
PSB-100W-24VDC-2XK-TB
PSB-2x100W-24VDC-2XK-TB
PSB-3x100W-24VDC-2XK-TB
PSB-4x100W-24VDC-2XK-TB



8.5" x 14" In-Wall Mounting Kit: Includes power supply, box cover and stud hangers for installing Junction Box in wall. Select "IW" in the options section of compatible power supply ordering codes if an In-Wall Mounting Kit is needed.

Ordering Codes:
PSB-100W-24VDC-2XK-IW

PROJECT		FIXTURE TYPE		DATE	

TM30 DATA

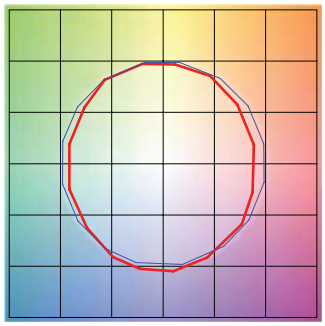
24VDC PLASTER-IN LED SYSTEM

REV 10.06.21

TM-30-15 DATA: The data below is for ST2A, ST5A and ST7A bare LED Soft Strips. Consistent color temperatures throughout a single strip and among multiple strips is possible through a 3 phase binning process in which each order is inspected with a color meter to ensure uniformity.

2200K | Rf: 83.9 | Rg: 94.9

Color Vector Graphic

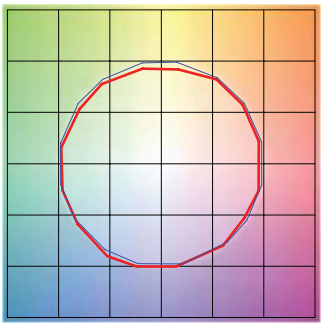


Test Reference

		GRAPHIC SHIFTS %	
HUE BIN	Rf	CHROMA	HUE
1	78.8	-9.5%	1.3%
2	80.7	-7.8%	6.7%
3	78.2	-3.3%	9.4%
4	89.7	-2.8%	3.6%
5	93.2	-0.8%	2.6%
6	93.0	-0.6%	-0.7%
7	87.7	-5.9%	-3.5%
8	89.2	-6.8%	1.9%
9	83.4	-5.6%	6.0%
10	79.3	-3.7%	10.8%
11	81.4	2.9%	11.1%
12	84.9	5.3%	4.9%
13	88.1	4.9%	-10.1%
14	68.1	0.1%	-19.5%
15	86.0	-3.3%	-7.3%
16	76.4	-8.9%	-11.7%

2400K | Rf: 91.2 | Rg: 96.8

Color Vector Graphic

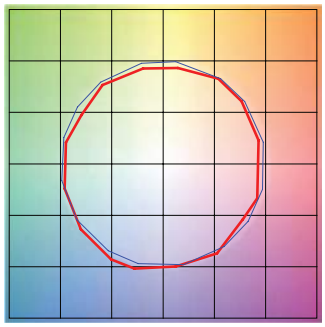


Test Reference

		GRAPHIC SHIFTS %	
HUE BIN	Rf	CHROMA	HUE
1	92.0	-2.4%	1.5%
2	94.7	-2.1%	0.0%
3	95.4	-1.9%	-0.1%
4	88.7	-6.7%	-3.1%
5	92.8	-5.6%	1.0%
6	92.7	-3.4%	3.4%
7	89.9	-4.3%	4.1%
8	92.4	-1.4%	4.4%
9	89.0	-0.6%	5.8%
10	88.9	0.4%	6.2%
11	89.7	4.0%	5.4%
12	92.6	3.0%	-0.7%
13	90.9	1.1%	-7.0%
14	89.9	0.5%	-5.8%
15	92.1	-3.2%	0.1%
16	88.9	-1.7%	-6.3%

2700K | Rf: 87.7 | Rg: 96.1

Color Vector Graphic

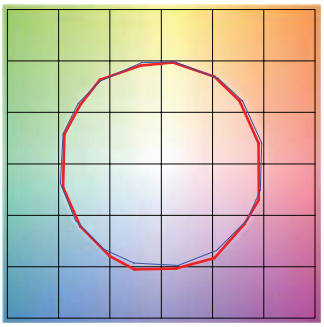


Test Reference

		GRAPHIC SHIFTS %	
HUE BIN	Rf	CHROMA	HUE
1	88.0	-4.3%	2.6%
2	91.6	-2.4%	2.0%
3	93.7	-1.4%	1.9%
4	88.9	-5.6%	-3.1%
5	92.3	-5.5%	-0.5%
6	92.9	-3.5%	0.1%
7	84.5	-7.5%	4.6%
8	90.8	-3.0%	4.4%
9	84.5	-1.3%	8.3%
10	83.9	2.0%	9.8%
11	87.2	5.3%	7.1%
12	89.2	5.4%	-2.6%
13	88.7	0.3%	-7.8%
14	86.8	1.7%	-9.3%
15	87.6	-5.4%	-1.3%
16	83.6	-3.3%	-9.5%

3000K | Rf: 88.1 | Rg: 99.7

Color Vector Graphic

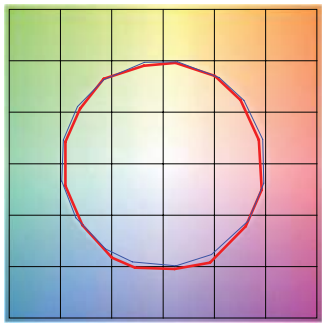


Test Reference

		GRAPHIC SHIFTS %	
HUE BIN	Rf	CHROMA	HUE
1	92.5	-3.1%	0.3%
2	93.3	-2.3%	1.9%
3	90.9	-0.8%	3.9%
4	94.3	-1.1%	1.4%
5	92.5	-2.6%	1.5%
6	96.4	1.2%	-0.3%
7	92.6	-2.5%	-0.0%
8	96.9	-1.4%	0.2%
9	92.3	-1.8%	4.3%
10	86.6	-0.7%	7.0%
11	86.5	2.4%	8.2%
12	89.8	5.9%	1.7%
13	93.9	2.6%	-2.7%
14	89.4	5.1%	-5.8%
15	90.1	-0.1%	-4.7%
16	86.5	0.3%	-9.7%

3500K | Rf: 86.1 | Rg: 95.5

Color Vector Graphic

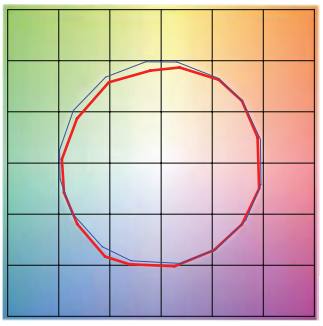


Test Reference

		GRAPHIC SHIFTS %	
HUE BIN	Rf	CHROMA	HUE
1	90.8	-3.8%	0.3%
2	92.3	-2.8%	2.1%
3	89.7	-1.0%	4.3%
4	92.6	-1.4%	1.7%
5	91.8	-3.1%	1.3%
6	96.2	0.8%	-0.4%
7	92.9	-3.2%	0.2%
8	94.3	-2.5%	1.5%
9	90.4	-2.5%	5.2%
10	84.3	-1.4%	9.5%
11	83.1	3.5%	9.8%
12	88.2	4.8%	3.4%
13	94.0	2.7%	-2.0%
14	88.7	5.9%	-5.8%
15	88.7	0.7%	-5.9%
16	86.8	-0.7%	-6.7%

4000K | Rf: 87.6 | Rg: 96.8

Color Vector Graphic



Test Reference

		GRAPHIC SHIFTS %	
HUE BIN	Rf	CHROMA	HUE
1	88.9	-2.4%	2.5%
2	93.3	-0.4%	0.8%
3	94.8	-1.0%	-0.6%
4	87.9	-4.9%	-3.6%
5	85.3	-9.4%	-2.6%
6	90.2	-6.0%	0.2%
7	85.3	-7.6%	4.6%
8	83.7	-4.1%	8.2%
9	79.5	-1.1%	13.8%
10	78.6	1.5%	12.1%
11	83.5	6.4%	7.8%
12	90.9	3.6%	-1.1%
13	88.3	1.7%	-6.3%
14	91.9	-0.4%	-2.2%
15	84.5	-0.9%	-5.5%
16	84.7	-1.1%	-4.4%

PROJECT		FIXTURE TYPE		DATE	

TM30 DATA

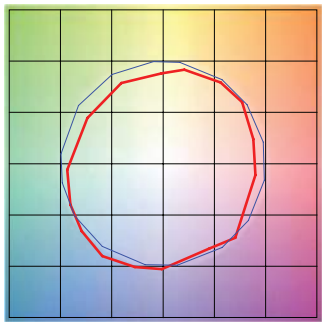
24VDC PLASTER-IN LED SYSTEM

REV 10.06.21

TM-30-15 DATA: The data below is for ST2A, ST5A and ST7A bare LED Soft Strips. Consistent color temperatures throughout a single strip and among multiple strips is possible through a 3 phase binning process in which each order is inspected with a color meter to ensure uniformity.

5700K | Rf: 80.3 | Rg: 91.5

Color Vector Graphic

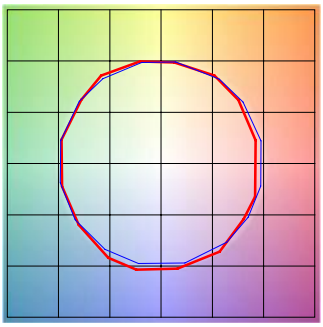


Test Reference

		GRAPHIC SHIFTS %	
HUE BIN	Rf	CHROMA	HUE
1	75.4	-8.9%	4.7%
2	87.5	-2.6%	4.6%
3	90.7	-3.0%	-0.5%
4	83.2	-6.0%	-5.7%
5	76.2	-12.9%	-5.3%
6	81.4	-11.9%	-2.6%
7	74.8	-14.0%	5.1%
8	69.0	-9.0%	14.1%
9	72.6	-3.6%	22.2%
10	71.4	2.7%	16.1%
11	81.3	7.9%	5.3%
12	83.6	4.1%	-9.4%
13	78.4	0.7%	-15.3%
14	77.7	-6.2%	-11.0%
15	68.8	-1.3%	-21.2%
16	80.8	-9.6%	3.3%

2700D | Rf: 89.5 | Rg: 100.8

Color Vector Graphic

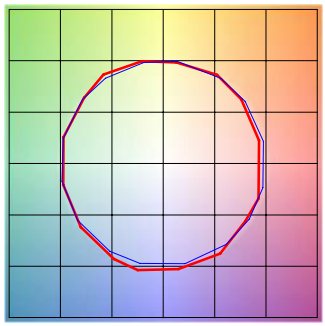


Test Reference

		GRAPHIC SHIFTS %	
HUE BIN	Rf	CHROMA	HUE
1	88.8	-5.1%	1.4%
2	89.8	-2.7%	4.1%
3	87.2	0.3%	5.9%
4	92.3	-0.9%	1.0%
5	93.3	1.5%	1.7%
6	92.4	3.6%	-0.2%
7	92.2	-0.9%	-2.4%
8	96.7	-0.4%	-1.1%
9	92.3	-1.2%	3.7%
10	88.9	-0.0%	6.1%
11	86.4	5.1%	7.4%
12	88.2	6.3%	-0.9%
13	87.2	3.8%	-8.1%
14	84.2	3.8%	-11.0%
15	89.8	-2.6%	-4.3%
16	82.7	-3.4%	-11.1%

3000D | Rf: 89.8 | Rg: 101.4

Color Vector Graphic

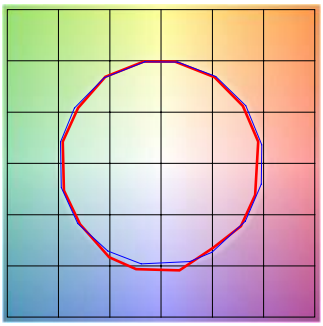


Test Reference

		GRAPHIC SHIFTS %	
HUE BIN	Rf	CHROMA	HUE
1	90.2	-4.2%	1.5%
2	90.9	-2.0%	3.7%
3	87.9	0.8%	5.5%
4	92.1	-0.9%	0.6%
5	93.0	1.5%	1.6%
6	92.2	3.9%	-0.2%
7	92.1	-0.3%	-2.0%
8	96.7	0.0%	-1.2%
9	92.5	-0.6%	3.7%
10	88.3	1.1%	7.0%
11	87.2	4.1%	7.4%
12	87.2	6.7%	-1.0%
13	88.2	3.8%	-7.2%
14	85.3	4.3%	-9.9%
15	90.9	-2.2%	-3.6%
16	83.4	-2.2%	-11.2%

2000K ONLY (2K6K/27K6) | Rf: 90.6 | Rg: 98.5

Color Vector Graphic

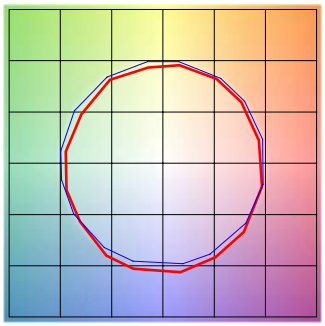


Test Reference

		GRAPHIC SHIFTS %	
HUE BIN	Rf	CHROMA	HUE
1	87.7	-5.5%	1.2%
2	88.7	-3.9%	4.2%
3	90.5	-1.5%	4.3%
4	95.0	-1.7%	0.8%
5	95.2	-0.2%	2.1%
6	94.2	1.6%	1.9%
7	95.9	-0.8%	-2.2%
8	95.5	-1.7%	1.3%
9	93.8	-1.4	2.6%
10	91.9	-0.7%	4.2%
11	91.3	3.6%	3.7%
12	91.2	4.2%	-1.0%
13	86.6	3.8%	-12.7%
14	67.2	-3.0%	-16.3%
15	84.9	-3.3%	-9.4%
16	84.2	-5.7%	-7.5%

4000K ONLY (2K6K/27K6) | Rf: 86.4 | Rg: 96.1

Color Vector Graphic

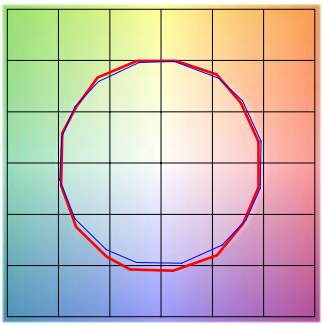


Test Reference

		GRAPHIC SHIFTS %	
HUE BIN	Rf	CHROMA	HUE
1	86.5	-5.5%	1.3%
2	90.4	-3.0%	2.3%
3	89.8	-2.1%	3.6%
4	89.1	-3.4%	0.4%
5	88.5	-5.9%	0.1%
6	93.6	-3.0%	-0.4%
7	88.9	-6.2%	1.7%
8	87.3	-5.0%	4.9%
9	82.4	-3.6%	11.3%
10	77.4	-1.8%	12.7%
11	79.8	4.9%	11.4%
12	88.7	4.4%	2.7%
13	88.7	4.0%	-5.1%
14	91.2	2.2%	-3.8%
15	82.7	-0.1%	-9.2%
16	82.8	-2.2%	-7.6%

3000K (2K6K/27K6) | Rf: 90.5 | Rg: 100.7

Color Vector Graphic

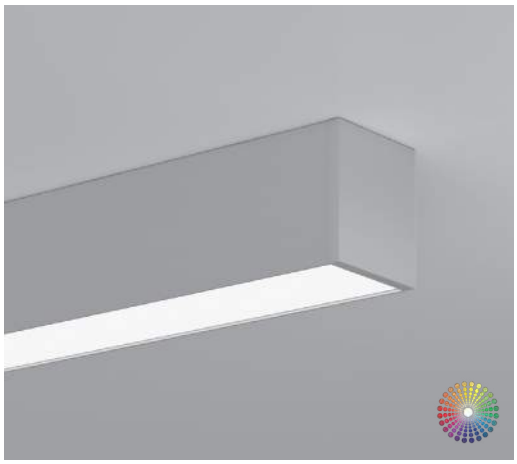


Test Reference

		GRAPHIC SHIFTS %	
HUE BIN	Rf	CHROMA	HUE
1	91.5	-3.5%	1.2%
2	92.4	-1.8%	2.7%
3	89.8	0.3%	4.5%
4	92.4	-1.7%	0.4%
5	93.3	-0.1%	1.4%
6	94.5	2.1%	-0.6%
7	91.0	-2.5%	0.3%
8	96.9	-0.8%	-0.2%
9	91.6	-0.9%	4.6%
10	86.7	0.7%	7.8%
11	86.3	3.8%	8.5%
12	88.3	6.1%	0.6%
13	90.9	3.1%	-5.2%
14	87.3	4.7%	-7.9%
15	92.1	-1.9%	-2.5%
16	84.5	-0.9%	-10.9%

PROJECT		FIXTURE TYPE		DATE	

Beam 2 Square | RGB+W Surface mount - Direct



Spotless lens

Project _____

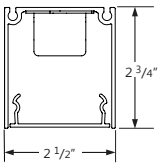
Type _____

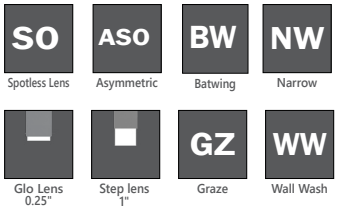
Notes _____

PERFORMANCE PER LINEAR FOOT

NOMINAL LUMEN OUTPUT	INPUT WATTS*	EFFICACY	SHIELDING
1100 lm/ft	16.4 W/ft	67 lm/W	SO
1100 lm/ft	16.4 W/ft	67 lm/W	0.25G
1200 lm/ft	16.4 W/ft	73 lm/W	1M
1000 lm/ft	16.4 W/ft	61 lm/W	NW
1000 lm/ft	16.4 W/ft	61 lm/W	GZ
1000 lm/ft	16.4 W/ft	61 lm/W	WW
1000 lm/ft	16.4 W/ft	61 lm/W	ASO
950 lm/ft	16.4 W/ft	59 lm/W	BW

Please consult factory for custom lumen output and wattage.





Ordering Guide

B2SQSLED				90							
PRODUCT ID		**NOM. LUMENS/FT**		**CRI**		**COLOR TEMP. (choose one)**		**SHIELDING**		**LENGTH**	
B2SQSLED	RGB+W Surface Direct	**1200**	1200 lm/ft	**90**	90 CRI	**CTRGBW30**	RGB+30K White - Color Tuning	**SO**	spotless lens	**4**	4′
		1000	1000 lm/ft - for GZ, NW, WW, ASO, BW*			**CTRGBW35**	RGB+35K White - Color Tuning	**0.25G**	0.25" Glo lens	**5**	5′
						CTRGBW40	RGB+40K White - Color Tuning	**1M**	StepLens , lum. end cap	**6**	6′
								ASO	asymmetric, flush only	**8**	8′
								BW	batwing, flush only	**12**	12′
								NW	narrow, flush only	**S(L)**	system run
								GZ	graze, flush only		
								WW	wallwash, flush only		
						Available with CT(DMX) driver only.				3" increments are available for lengths over 4 feet.	

				CT(DMX)							
FINISH		**VOLTAGE**		**DRIVER**		**CIRCUITS**		**MOUNTING**		**CUSTOM (OPT.)**	
AP	aluminum paint	**120**	120 V	**CT(DMX)**	color tuning driver	**1**	1 circuit	**SB9**	surface TB/TG 9/16	**C**	custom
W	white	**277**	277 V			**+E(#)**	emergency circuit*	**SB15**	surface TB/TG 15/16		
BLK	black	**UNV**	universal					**SBS**	surface screw slot t-bar		
C	custom							**S**	surface drywall ceiling		
								SC	surface solid ceiling		
						*Specify quantity				Please specify	

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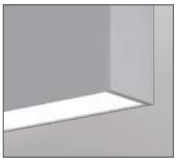
axislighting.com

SPECIFICATIONS

CONSTRUCTION

Housing	Extruded aluminum (0.075'' nominal) Up to 70% recycled content
End Cap	Cast aluminum
Interior Brackets	Die formed sheet steel (20 gauge)
Reflectors	White powder coated sheet steel (22 gauge)
Lenses	Extruded acrylic (0.070'' nominal)

OPTICS



SO Spotless lens
ASO Asymmetric lens
WW Wall Wash
NW Narrow Distribution
GZ Graze
BW Batwing

0.25G Glo lens

1M Step lens

SPOTLESS LENS
Frosted acrylic snap-in micro lens. Used for SO, ASO, BW, NW, GZ and WW shielding options.

GLO LENS
0.25" frosted acrylic drop lens. Patented design.

SYSTEM (S#)

BEAM2 SQUARE linear systems, with the use of a strong profile, allow for a nearly hair thin connection system of continuous runs. Lengths of 4', 8', 12' as well as custom lengths are available. Runs of BEAM2 SQUARE that are greater than 12' in length are designated as systems (S#). This means that the run is comprised of a combination of 4', 8' and/or 12' sections to be assembled on site using our joining system. For more information on systems and joining, please refer to the BEAM installation sheets available for download at www.axislighting.com.

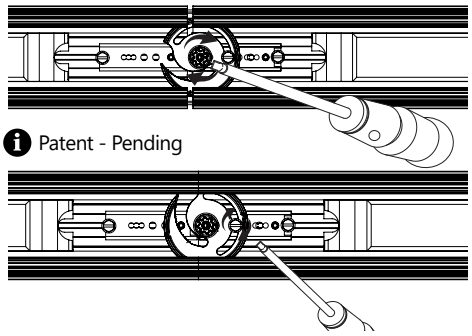
InstaJoiner

BEAM2 SQUARE luminaires feature InstaJoiner, a unique, patent-pending joining system developed by Axis offering fast, single-screw tightening.

NOTE: Mount each system segment individually.

Do not assemble system prior to mounting

Allow a minimum of 6" between end of long runs and wall.



Patent - Pending

ELECTRICAL

RGB+W color tuning CT driver	DMX - Standard
Emergency	Emergency circuit optional.
Input Voltage	120V, 277V, UNV.

Incorporating these components may have limitations or affect the length of the luminaire. Please contact factory for more details.

LED SYSTEM

CRI Color Tuning	90 CRI for CTRGBW. **Note: RGB+W allows you to select the 'white point' (CCT) + CRI, delivering a more flexible and powerful white than standard RGBW.**
CCT Color Tuning	**30** (3000K) **35** (3500K) **40** (4000K) Consult Axitune technical sheet for more information on color technology.
LED life	Minimum 50,000h with 85% of lumen maintenance in 25°C ambient temperature, in compliance with IES LM-80 testing measurements.
Thermal Management	Aluminum housing acting as the heat sink to maximize life.
Environment	Dry and damp rated for indoor use only in operating ambient temperatures of -20° - +40°C (-4 - +104F).

WARRANTY

Limited 5-year warranty is available. Warranty is valid provided luminaires are installed and used according to specifications. For full terms and conditions, please consult warranty section at axislighting.com.

APPROVALS

Certified to UL and CUL standards
Meets NYC requirements
Meets ADA requirements.
Suitable for damp locations, indoor only.

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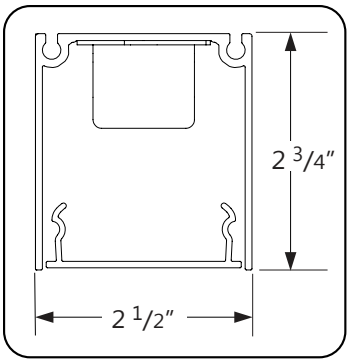
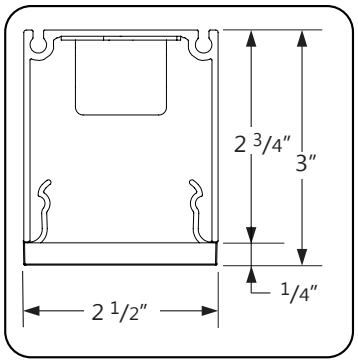
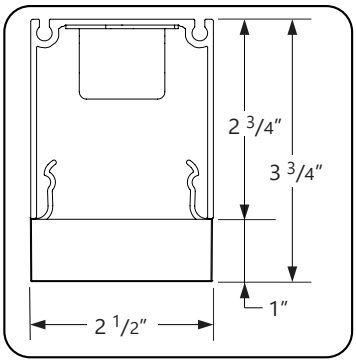
SECTION VIEWS





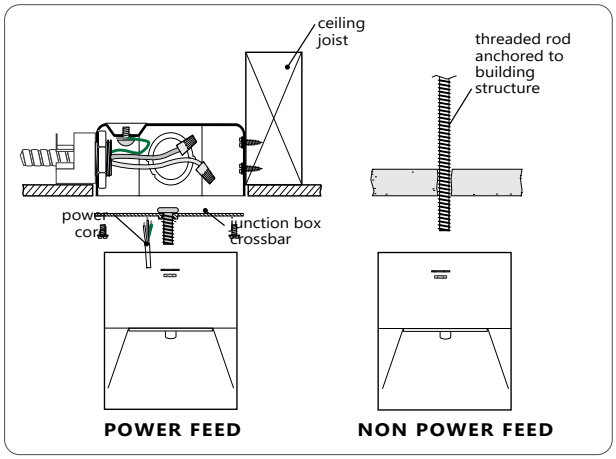


SO Spotless lens
ASO Asymm. lens
NW Narrow lens
GZ Graze lens
WW Wallwash lens
UB Ultra Blend lens
BW Batwing lens

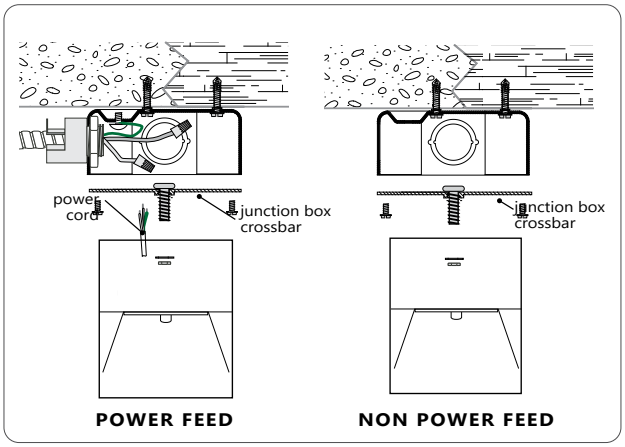
0.25G 0.25" Glo lens

1M 1" Step Lens

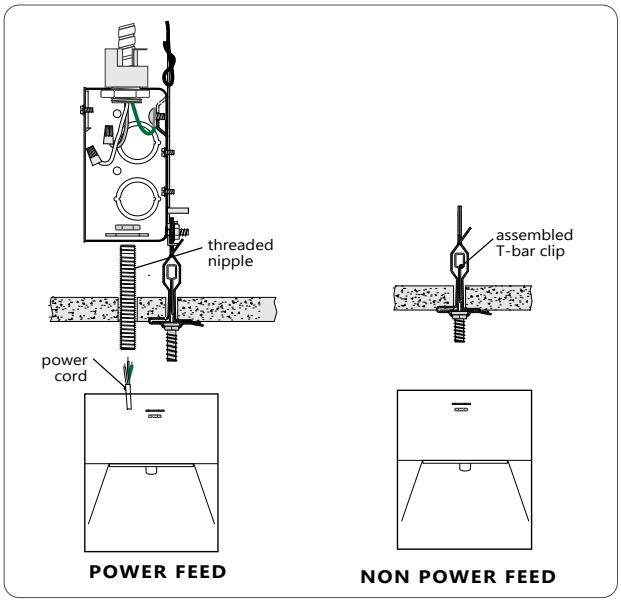
MOUNTING DETAILS



S SURFACE MOUNT DRYWALL CEILING



SC SURFACE MOUNT SOLID CEILING



SB9 **SB15** **SBS** SURFACE MOUNT T-BAR CEILING

OTHER MOUNTING OPTIONS

BEAM 2 SQUARE is also available with surface, wall, and recessed mounting options.

Specification sheets and installation sheets for all mountings for BEAM 2 SQUARE luminaires are available for download at www.axislighting.com

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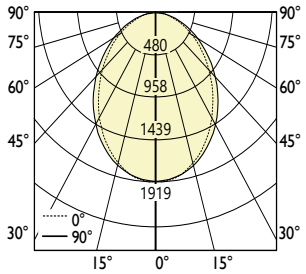
● *PHOTOMETRIC DATA*

SO - Spotless lens

1100 lm/ft

PHOTOMETRIC CURVE



Lumen/ft: 1100 lm/ft
Total Lumens: 4401 lm (for 4ft)
Input Watts: 65.41 W
Efficacy: 67 lm/W
IES FILE: B2SQxxLED-1100-90-CTRGBW30-SO-4.ies

TESTED ACCORDING TO IES LM-79-2008

CANDELA DISTRIBUTION

Vertical Angle	Horizontal Angles 0	22.5	45	67.5	90
0	1916	1916	1916	1916	1916
5	1905	1896	1893	1889	1885
15	1802	1783	1758	1740	1735
25	1608	1576	1537	1497	1483
35	1346	1309	1256	1205	1187
45	1052	1019	964	911	891
55	759	732	685	640	626
65	486	467	435	404	394
75	250	238	223	206	202
85	69	63	56	49	48
90	4	4	3	3	3

ZONAL LUMENS

Zone	Lumens
0	
0-10	180
10-20	502
20-30	722
30-40	808
40-50	769
50-60	638
60-70	453
70-80	253
80-90	76
90	

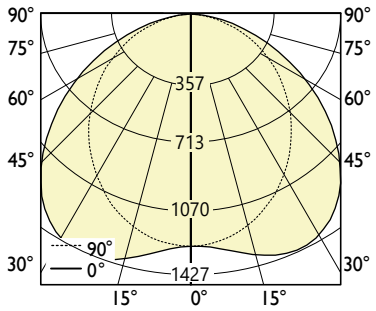
LUMINANCE DATA (cd/m²)

Vertical Angle	Horizontal Angles 0	45	90
45	20339	18626	17230
55	18086	16333	14909
65	15732	14062	12727
75	13187	11766	10651
85	10894	8816	7522

BW Batwing

950 lm/ft

PHOTOMETRIC CURVE



Lumen/ft 950 lm/ft
Luminaire Lumens: 3848 lm
Input Watts: 65.41 W
Efficacy: 59 lm/W
IES FILE: B2SQxxLED-950-90-CTRGBW30-BW-4.ies

TESTED ACCORDING TO IES LM-79-2008

CANDELA DISTRIBUTION

Vertical Angle	Horizontal Angles 0	22.5	45	67.5	90
0	1122	1122	1122	1122	1122
5	1114	1119	1129	1140	1145
15	1055	1088	1163	1242	1275
25	944	1012	1186	1351	1404
35	800	893	1134	1346	1411
45	644	744	1005	1161	1198
55	486	569	762	883	906
65	329	383	502	577	587
75	173	197	256	287	292
85	37	44	57	60	60
90	3	2	3	3	3

ZONAL LUMENS

Zone	Lumens
0	
0-10	108
10-20	330
20-30	543
30-40	694
40-50	731
50-60	646
60-70	472
70-80	258
80-90	66
90	

LUMINANCE DATA (cd/m²)

Vertical Angle	Horizontal Angles 0	45	90
45	12442	19428	23148
55	11573	18151	21582
65	10650	16240	18994
75	9152	13518	15407
85	5724	8909	9437

ℹ All IES files for other lamping are available for download at: www.axislighting.com

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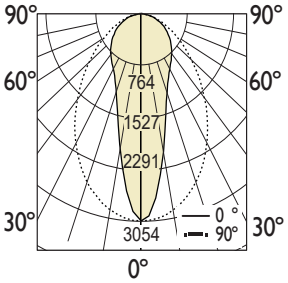
● *PHOTOMETRIC DATA*

NW narrow - **Down**

1000 lm/ft

PHOTOMETRIC CURVE



Lumen/ft: 1000 lm/ft
Total Lumens: 4007 lm (for 4ft)
Input Watts: 65.41 W
Efficacy: 61 lm/W
IES FILE: B2SQxxLED-1000-90-CTRGBW30-NW-4.ies

TESTED ACCORDING TO IES LM-79-2008

CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	0	22.5	45	67.5	90
0	3054	3054	3054	3054	3054
5	3032	2989	2875	2763	2731
15	2805	2460	1921	1619	1540
25	2392	1820	1266	1079	1041
35	1860	1325	936	852	842
45	1315	960	722	688	689
55	850	671	534	527	534
65	490	419	355	361	372
75	223	203	183	191	199
85	40	40	41	40	39
90	2	2	2	2	2

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	258
10-20	563
20-30	669
30-40	691
40-50	645
50-60	538
60-70	385
70-80	208
80-90	50
90	

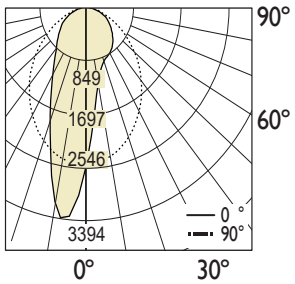
LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	0	45	90
45	25604	14059	13424
55	20396	12809	12829
65	15969	11554	12106
75	11883	9757	10581
85	6389	6471	6193

GZ Graze

750 lm/ft

PHOTOMETRIC CURVE



Lumen/ft 1000 lm/ft
Total Lumens: 4006 lm (for 4ft)
Input Watts: 65.41 W
Efficacy: 61 lm/W
IES FILE: B2SQxxLED-1000-90-CTRGBW30-GZ-4.ies

TESTED ACCORDING TO IES LM-79-2008

CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	0	22.5	45	67.5	90
0	2534	2534	2534	2534	2534
5	2484	2100	1835	1681	1651
15	2321	1446	1114	1010	991
25	2038	1060	879	866	873
35	1682	833	774	788	797
45	1294	667	648	653	663
55	892	507	493	512	535
65	511	333	333	367	392
75	219	168	175	201	216
85	38	34	37	39	38
90	2	2	2	2	2

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	234
10-20	561
20-30	686
30-40	701
40-50	647
50-60	539
60-70	384
70-80	205
80-90	48
90	

LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	0	45	90
45	25201	12620	12916
55	21421	11840	12839
65	16648	10844	12779
75	11669	9287	11499
85	6043	5811	6045

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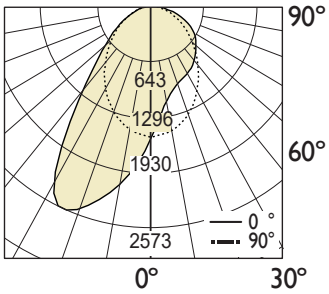
● *PHOTOMETRIC DATA*

WW Walwash

1000 lm/ft

PHOTOMETRIC CURVE



CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	0	22.5	45	67.5	90
0	1530	1530	1530	1530	1530
5	1501	1399	1327	1283	1272
15	1397	1154	1049	1012	1003
25	1203	950	901	904	909
35	961	782	791	825	842
45	720	628	657	704	734
55	505	470	495	575	626
65	319	306	331	427	475
75	162	156	175	239	263
85	33	34	40	50	46
90	3	3	3	3	2

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	146
10-20	438
20-30	704
30-40	802
40-50	712
50-60	560
60-70	385
70-80	202
80-90	47
90	

LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	0	45	90
45	14017	12801	14292
55	12117	11873	15022
65	10387	10788	15464
75	8600	9308	14006
85	5282	6357	7295

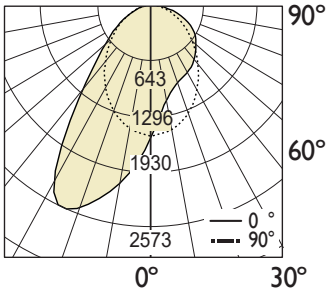
Lumen/ft: 1000 lm/ft
Total Lumens: 3997 lm (for 4ft)
Input Watts: 65.41 W
Efficacy: 61 lm/W
IES FILE: B2SQxxLED-1000-90-CTRGBW30-WW-4.ies

TESTED ACCORDING TO IES LM-79-2008

ASO Asymmetric

1000 lm/ft

PHOTOMETRIC CURVE



CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	0	22.5	45	67.5	90
0	1530	1530	1530	1530	1530
5	1501	1399	1327	1283	1272
15	1397	1154	1049	1012	1003
25	1203	950	901	904	909
35	961	782	791	825	842
45	720	628	657	704	734
55	505	470	495	575	626
65	319	306	331	427	475
75	162	156	175	239	263
85	33	34	40	50	46
90	3	3	3	3	2

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	146
10-20	438
20-30	704
30-40	802
40-50	712
50-60	560
60-70	385
70-80	202
80-90	47
90	

LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	0	45	90
45	14017	12801	14292
55	12117	11873	15022
65	10387	10788	15464
75	8600	9308	14006
85	5282	6357	7295

Lumen/ft: 1000 lm/ft
Total Lumens: 3997 lm (for 4ft)
Input Watts: 65.41 W
Efficacy: 61 lm/W
IES FILE: B2SQxxLED-1000-90-CTRGBW30-ASO-4.ies

TESTED ACCORDING TO IES LM-79-2008

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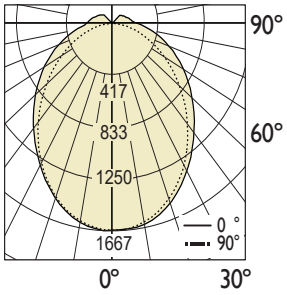
● *PHOTOMETRIC DATA*

1M 1" Step lens

1200 lm/ft

PHOTOMETRIC CURVE



Lumen/f: 1200 lm/ft
Total Lumens: 4797 lm (for 4ft)
Input Watts: 65.41 W
Efficacy: 73 lm/W
IES FILE: B2SQxxLED-1200-90-CTRGBW30-1M-4.ies

TESTED ACCORDING TO IES LM-79-2008

CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	0	22.5	45	67.5	90
0	1664	1664	1664	1664	1664
5	1651	1647	1647	1645	1647
15	1555	1550	1536	1521	1517
25	1375	1367	1345	1318	1311
35	1135	1135	1116	1099	1096
45	870	886	892	896	900
55	616	651	687	710	717
65	390	444	501	535	544
75	205	268	340	378	385
85	68	138	212	247	254
90	20	92	166	202	208
95	18	84	153	186	191
105	15	68	119	158	164
115	13	50	96	122	134
125	10	38	78	102	114

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	157
10-20	437
20-30	630
30-40	713
40-50	702
50-60	621
60-70	495
70-80	350
80-90	217
90	
90-100	144
100-110	115
110-120	85
120-130	62
130-140	
140-150	
150-160	
160-170	
170-180	69
180	

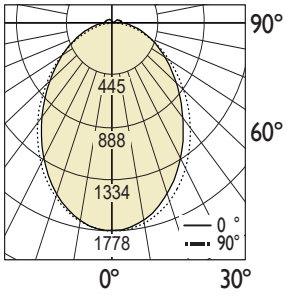
LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	0	45	90
45	15405	7301	6131
55	12983	5559	4720
65	10549	4137	3563
75	8081	2951	2592
85	5282	2004	1810

0.25G 0.25" Glo lens

1100 lm/ft

PHOTOMETRIC CURVE



Lumen/f: 1100 lm/ft
Total Lumens: 4399 lm (for 4ft)
Input Watts: 65.41W
Efficacy: 67 lm/W
IES FILE: B2SQxxLED-1100-90-CTRGBW30-0.25G-4.ies

TESTED ACCORDING TO IES LM-79-2008

CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	0	22.5	45	67.5	90
0	1776	1776	1776	1776	1776
5	1767	1763	1760	1756	1753
15	1669	1656	1643	1627	1622
25	1487	1466	1438	1407	1398
35	1239	1220	1182	1143	1129
45	965	950	915	879	867
55	694	687	667	640	631
65	445	449	445	436	433
75	231	245	260	267	269
85	70	91	118	134	140
90	9	33	62	81	88
95	9	28	52	69	75
105	7	21	40	60	66
115	7	16	32	46	52
125	9	14	27	37	44

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	167
10-20	465
20-30	667
30-40	747
40-50	716
50-60	603
60-70	445
70-80	276
80-90	126
90	
90-100	55
100-110	45
110-120	33
120-130	25
130-140	
140-150	
150-160	
160-170	
170-180	29
180	

LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	0	45	90
45	18646	17693	16752
55	16538	15882	15044
65	14388	14395	14006
75	12182	13754	14229
85	10901	18461	22013

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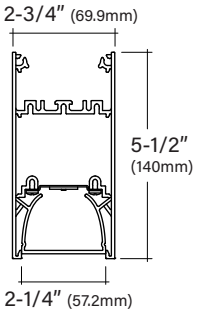
PINNACLE ARCHITECTURAL LIGHTING®

Project Name _____

Date _____ Type _____



EDGE EX2D

2" Suspended Direct Linear

Key Features

- 6063-T6 Extruded aluminum housing
- Room side maintenance for LED system
- 5-year limited warranty covers LED, driver and fixture
- ETL listed conforming to UL 1598 in US and CSA 250 in Canada
- Approved for dry/damp location unless otherwise noted
- Maximum weight is 20 lbs. for a standard 4' fixture
- Buy American Act compliant
- Run lengths available to an 1/8"
- Product transparency with third-party verified Living Building Challenge (LBC) Declared

Example Part #: EX2D-HE-N-830HO-26'-AC48G1-U-FSD-1-0-W

EX2D -	- N	-	-	-	-	-	-	-	-	-	-
DIRECT SHIELDING	*INDIRECT SHIELDING*	*SOURCE*	*LENGTH OR PATTERN*	*MOUNTING*	*VOLTAGE*	*DRIVER*	*CIRCUITING*	*BATTERY & EMERGENCY*	*FINISH*	*FIXTURE OPTIONS*	*CONTROLS*

__	N	_____	____
DIRECT SHIELDING	**INDIRECT SHIELDING**	**SOURCE** QS[1,2]	**LENGTH OR PATTERN**[3]
A - Satine Lens QS **AL** - Drop Lens **HE** - High Efficiency QS **BW** - Batwing QS **WHE** - Asymmetric QS **HED** - Descent *Shielding pg. 2*	**N** - None QS *Shielding pg. 2*	**_27__ -** 2700K **_30__ -** 3000K **_35__ -** 3500K **_40__ -** 4000K **TW __ -** 2CH Tunable White *(2700-6500K, 90CRI)* **CL_____ -** Custom Lumens **CW_____ -** Custom Watts **MOD** - Mod options available *Lumen Output pg. 2*	**__ -** Individual Fixture QS **__ -** Continuous Row QS **L _ x _ -** L Shape QS **R _ x _ -** Rectangle QS **S _ -** Square QS **U _ x _ x _ -** U-Shape QS **T _ x _ -** T Shape **X _ x _ x _ -** X Shape **MOD** - Mod options available *Length and Pattern pg. 3-4*

_____	_	___	_
MOUNTING	**VOLTAGE**[4]	**DRIVER**	**CIRCUITING**[5]
_AC_ _G_ - (M)AC to Grid QS **_AC_ _JB -** (M)AC to J Box QS **_AC_ _ST -** (M)AC to Structure QS **_AC5_ _G_ -** 5" Non-Power Canopy **_AC5_ _JB -** 5" Non-Power Canopy **_SQ_ _G_ -** 5" Square Canopy **_SQ_ _JB -** 5" Square Canopy **WA -** Wall Mount QS **S -** Surface Mount QS **MOD** - Mod options available *Mounting pg. 4*	**U -** Universal *(120 thru 277V)* QS **1 -** 120V QS **2 -** 277V QS **3 -** 347V *Voltage pg. 4*	**FSD -** Factory Select Driver *(1%, 0-10v)* QS **PL2 -** Advance Xitanium *(1%, 0-10v)* **OL2 -** eldoLED Optotronic *(1%, 0-10v)* **OL4 -** eldoLED Optotronic 347v *(1%, 0-10v)* **EE1 -** eldoLED ECOdrive *(1%, 0-10v)* **ES1 -** eldoLED SOLOdrive *(0.1%, 0-10v)* **LH1-** Lutron Hi-lume *(1%, EcoSystem)* **PR1 -** Advance Xitanium SR **MOD** - Mod options available *Driver pg. 5*	**1 -** Single Circuit QS **M -** Multi Circuit **E -** Emergency *(entire fixture)* QS **N -** Night Light *(entire fixture)* QS *Circuiting pg. 6*

___	__	____	___
BATTERY & EMERGENCY[6]	**FINISH**	**FIXTURE OPTIONS**[7]	**CONTROLS**[8]
0 - None QS **_FSB** - Factory Select Battery QS **_FSG -** Factory Select ALCR **_GI** - Iota ETS DR **_GB** - Bodine GTD **_ILL -** Iota 10W **_PLL -** Bodine 10W **_E -** Emergency Section **_N -** Night Light Section **_L -** Life Safety Section *Battery and Emergency pg. 5-6*	**W -** White QS **S -** Metallic Silver QS **BL -** Textured Black QS **BR -** Bronze **GR -** Graphite **CC -** Custom Color *Finish pg. 6*	**QS -** QuickShip QS **TC -** Indirect Top Cover *(ac mounting only)* **DSP -** Customer Supplied Battery/Driver/Sensor **MOD** - Mod options available *Fixture Options pg. 6*	**DLMFC -** Wattstopper DLM *(wired)* **DLMFS -** Wattstopper LLLC *(wireless)* **EASYS -** Philips EasySense *(wireless)* **SNSLM -** Encelium Sensilum *(wireless)* **WVLX -** Eaton Wavelinx *(wireless)* **VDO -** Lutron Vive Sensor *(wireless)* **VRF -** Lutron Vive Connected *(wireless)* **ENL_ -** Enlighted *(wireless)* **MOD** - Mod options available *Controls pg. 7*

[1]When specifying SOURCE the first _ is for specifying either **8** - 80CRI, **9** - 90CRI. The ending __ are for specifying output, example 835HO - 80CRI, 3500K High Output. See output charts for more information. [2]When specifying Tunable White, use **TW** and then specify output, example TWHO - Tunable White 90CRI, High Output 2700-6500K. See output charts for more information. Tunable White option requires driver option **FSD** which provides separate 0-10v control leads for Intensity and CCT. [3]Individual fixtures come in **2', 3', 4', 5', 6', 7'** & **8'** lengths. Continuous row come in 1/8" increments. For Patterns specify pattern shape and overall dimensions. Example: L6x4: L pattern that is 6'x4'. [4]Specify AC Cable: Standard single AC = **AC** or Movable AC = **MAC**; Specify AC length standard AC is 48"; Specify grid: **G1**=15/16", **G9**=9/16", **GS**=Screw Slot. Example: AC48G1 [5]Tunable White (**TW**) option only available with Universal (**U**), 120V (**1**) or 277V (**2**) options. [6]Consult factory for Emergency (**E**) or Night Light (**N**) options with Tunable White (**TW**) option. [7]Enter quantity for Battery and Emergency, Example 2P. [8]When ordering QuickShip, **QS** must be used in fixture options section of part number to qualify. 1/8" increments not available for QS. [9]Controls can only be used with Single Circuit (**1**) or Emergency Circuit (**E**). See Controls chart on page 5 for driver options and more information.

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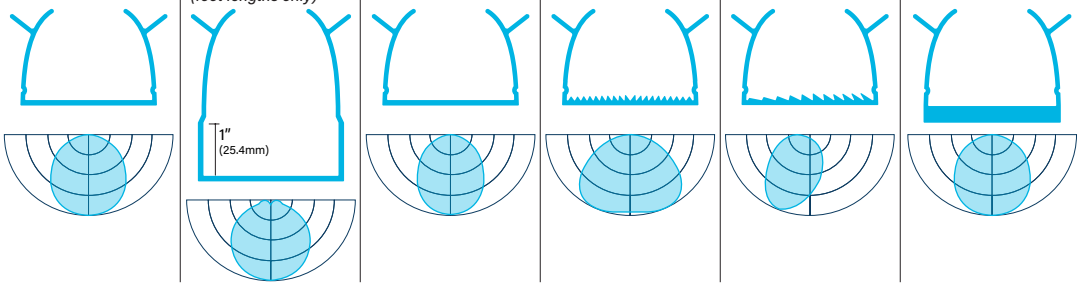
Direct Shielding

A	AL	HE	BW	WHE	HED
Satine Lens	Drop Lens *(foot lengths only)*	High Efficiency	Batwing	Asymmetric	Descent



Indirect Shielding

N
None

Source

- Specify either 80 or 90 CRI for White light LED
- Longer lead-time may apply for 90 CRI or Tunable White option. Consult factory
- Tunable White option requires driver option FSD which provides separate 0-10v control leads for Intensity and CCT.
- Tunable White lumen packages shown at 4000K CCT setpoint
- 90 CRI = R9≥50

Custom Output - Lumens OR Wattage

CL _____	Specify CRI, CCT and desired lumens (i.e. CL835500)	*Specify lumens between standard offering listed below. Lumens are specified per color temp*
CW _____	Specify CRI, CCT and desired wattage (i.e. CW9407)	*Specify watts between standard offering listed below*
CLTW_ _ _ _	Specify desired lumens for Tunable White (i.e. CLTW3200)	*Specify lumens between Tunable White offering listed below. Lumens are specified at 4000K CCT setpoint.*

80 CRI

	Color	Lumens per foot	Shielding[1] A Satine		AL Drop		HE High Efficiency		BW Batwing		WHE Asymmetric		HED Descent	
			LPW	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*
830	3000K	500	101	4.9	101	4.9	119	4.2	119	4.2	116	4.3	98	5.1
830HO		750	101	7.4	103	7.3	119	6.3	119	6.3	116	6.5	99	7.6
830VHO		1000	103	9.8	105	9.5	122	8.2	122	8.2	119	8.4	99	10.1
835	3500K	500	102	4.9	105	4.8	123	4.1	123	4.1	120	4.2	101	5.0
835HO		750	104	7.2	107	7.0	123	6.1	123	6.1	120	6.3	101	7.5
835VHO		1000	106	9.4	107	9.3	126	8.0	126	7.9	123	8.2	102	9.8
840	4000K	500	102	4.9	105	4.8	123	4.1	123	4.1	120	4.2	101	5.0
840HO		750	104	7.2	107	7.0	123	6.1	123	6.1	120	6.3	101	7.5
840VHO		1000	106	9.4	107	9.3	126	8.0	126	7.9	123	8.2	102	9.8

90 CRI

927	2700K	500	82	6.1	83	6.0	99	5.1	99	5.1	96	5.2	79	6.4
927HO		750	84	9.0	85	8.8	98	7.6	99	7.6	98	7.7	80	9.3
927VHO		1000	82	12.2	83	12.0	100	10.0	100	10.0	97	10.3	79	12.7
930	3000K	500	89	5.6	91	5.5	105	4.7	106	4.7	103	4.9	86	5.8
930HO		750	91	8.3	93	8.1	108	7.0	108	7.0	105	7.1	88	8.5
930VHO		1000	90	11.1	92	10.8	108	9.3	108	9.2	107	9.4	86	11.6
935	3500K	500	89	5.6	91	5.5	105	4.8	105	4.8	103	4.9	86	5.8
935HO		750	90	8.3	92	8.1	107	7.0	107	7.0	105	7.2	88	8.6
935VHO		1000	90	11.1	92	10.9	108	9.3	108	9.3	106	9.4	86	11.7
940	4000K	500	89	5.6	91	5.5	105	4.8	105	4.8	103	4.9	86	5.8
940HO		750	90	8.3	92	8.1	107	7.0	107	7.0	105	7.2	88	8.6
940VHO		1000	90	11.1	92	10.9	108	9.3	108	9.3	106	9.4	86	11.7

2 CH Tunable White (2700-6500K, 90CRI)

TW	2700 - 6500K	500	79.0	6.3	N/A	95.8	5.2	93.9	5.4	93.3	5.4	N/A
TWHO		750	74.9	10.0		92.9	8.1	89.9	8.3	89.9	8.3	
TWVHO		1000	N/A			N/A		N/A		N/A		

Direct Source: MOD Options

- Specify **MOD** in the part number for any of the below options
- All RGB_ Source Options will require specific driver and control
- Consult factory for **MOD** specification details, pricing, and lead-time information

		Required Driver	Required Control
MOD	Color Changing RGB LED	EC1/EC4	DMX
	Color Changing RGB-W LED	EC1/EC4	DMX

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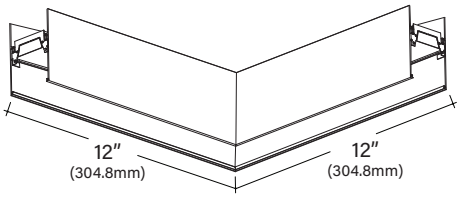
Length

- For Continuous Runs, add 3/16″ (4.7mm) for each end plate or 3/8″ (9.5mm) to the overall length of the row

2	3	4	5	6	7	8	–
Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Cont. Run *Specify nominal overall row length to the 1/8″ Longer lead-time may apply for lengths to the 1/8″. Consult factory.*

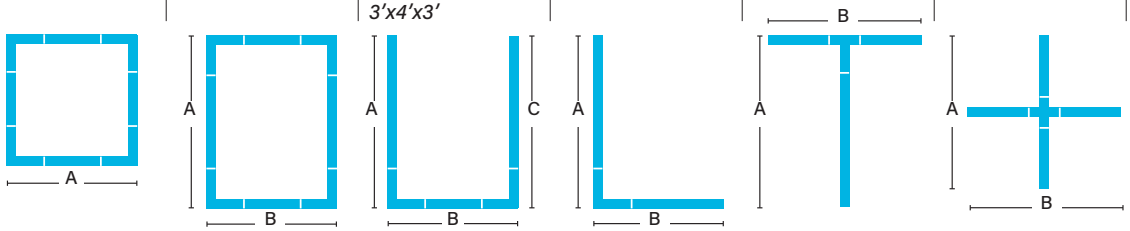
- 24-3/8″ (619.1mm)
- 36-3/8″ (934.8mm)
- 48-3/8″ (1228.7mm)
- 60-3/8″ (1533.5mm)
- 72-3/8″ (1838.3mm)
- 84-3/8″ (2143.1mm)
- 96-3/8″ (2447.9mm)
- Specify to the 1/8″

Pattern



- Specify pattern shape and overall dimensions (includes corner dimensions)
- Refer to dimensions table below for available standard lengths
- All connectors are direct only
- 90 degree horizontal corners are 12″x12″ (overall, outside dimension)
- Angles and shapes not shown require Mod Pattern; consult factory
- Only available with "A" or "HE" lens options

S_	R_x_	U_x_x_	L_x_	T_x_	X_x_	M
Square *Provide A dimension Example:* **S4′** *Minimum Length- 4′x4′*	Rectangle *Provide AxB dimensions Example:* **R4′x4′** *Minimum Length- 4′x4′*	U-Shape *Provide AxBxC dimensions Example:* **U3′x4′x3′** *Minimum Length- 3′x4′x3′*	L-Shape *Provide AxB dimensions Example:* **L3′x3′** *Minimum Length- 3′x3′*	T-Shape *Provide AxB dimensions Example:* **T3′x5′** *Minimum Length- 3′x5′*	X-Shape *Provide AxB dimensions Example:* **X5′x5′** *Minimum Length- 5′x5′*	Mod Layout *For patterns or lengths not shown or standard*

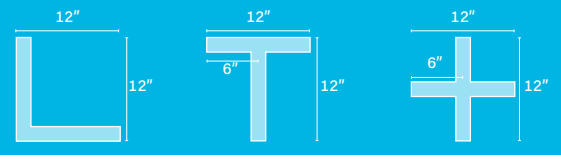


Length or Pattern: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Specify MOD for patterns, lengths or angles not shown above
	45- 180 degree angles
	Single-piece welded housings up to 4′ x 4′

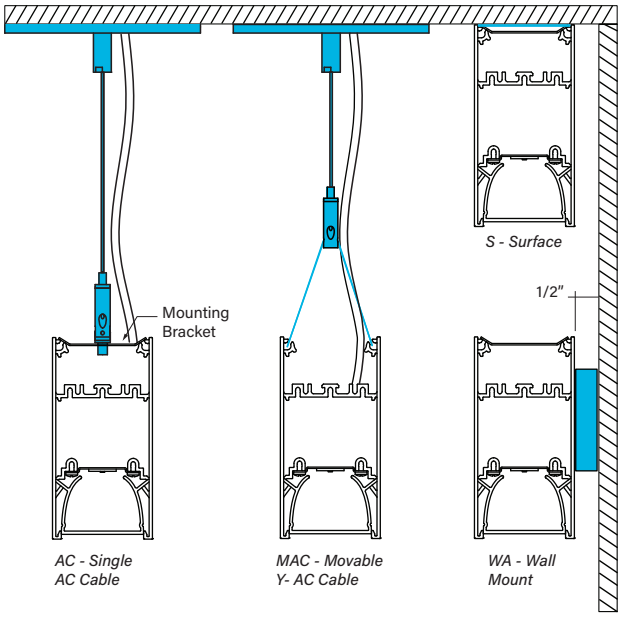
Horizontal Details: Every Connection is 12″ x 12″ in Overall Dimension



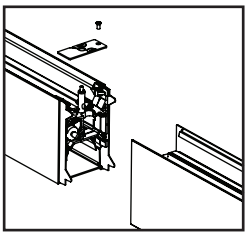
Mounting

- Specify cable length in ordering code (AC48G1)
- Standard adjustable cable. Specify 48", 120", 240" or 350"
- End plates and power cord attached at factory
- Aircraft cable (AC) mounts on 4' (1219.2mm) and 8' (2438.4mm) centers
- Maximum recommended movable mounting locations are 12" from end of 4' fixture and 18" from end of 8' fixture
- AC Cable supplied with 5" (127mm) power and 2" (50.8mm) non-power canopies
- Canopies and pendants match fixture finish, power cords are white or black depending on fixture finish. See Finish section for additional details.
- Approved for dry/damp location unless otherwise noted
- Refer to installation instructions during installation at the job site
- Maximum fixture weight is 20 lbs for a standard 4' fixture
- Top Cover is optional on AC mounting fixtures, Top Cover is standard on others

AC__G1	Aircraft Cable 1" (15/16") T-Bar
AC__G9	Aircraft Cable 9/16" T-Bar
AC__GS	Aircraft Cable Screw Slot T-Bar
AC__JB	Aircraft Cable Junction Box
AC__ST	Aircraft Cable Structure
AC5__G_	Aircraft Cable 5" (127mm) Non-Power Canopy
AC5__JB	Aircraft Cable 5" (127mm) Non-Power Canopy
SQ__G_	Aircraft Cable 5" (127mm) Square Canopy
SQ__JB	Aircraft Cable 5" (127mm) Square Canopy
MAC__G1	Movable AC 1" (15/16") T-Bar
MAC__G9	Movable AC 9/16" T-Bar
MAC__GS	Movable AC Screw Slot T-Bar
MAC__JB	Movable AC Junction Box
MAC__ST	Movable AC Structure
MAC5__G_	Movable AC 5" (127mm) Non-Power Canopy
MAC5__JB	Movable AC 5" (127mm) Non-Power Canopy
MSQ__G_	Movable AC 5" (127mm) Square Canopy
MSQ__JB	Movable AC 5" (127mm) Square Canopy
WA	Wall Mount
S	Surface Mount



Straight EDGE Joint System



- The Straight EDGE Joint comes standard for all runs.
- Two connection points – one to cinch fixtures together, the other to perfectly align all fixtures in a run.
- Factory-installed light shields on both sides of the fixture ensure no light leaks.
- Patented.

Mounting: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Recessed to Suspended
	Pendant Pipe

Voltage

- Some EX2D configurations will not accommodate all voltage options; consult with factory
- 347 volt not available with Tunable White (TW) option

U	Universal
1	120 volt
2	277 volt
3	347 volt

Driver

- Standard Driver Option = FSD
- Driver Lifetime: 50,000 hours at 25°C ambient operating conditions
- For more driver options see Pinnacle Resource Guide
- Some EX2D configurations will not accommodate all driver options; consult with factory

0-10V Drivers	
FSD	Factory Select Driver 1%, 0-10v
PL2	Signify Advance Xitanium 1%, 0-10v
PL4	Advance Xitanium 347v 1%, 0-10v, requires 347v
OL2	eldoLED Optotronic, 1%, 0-10v
OL4	eldoLED Optotronic 347v, 1% 0-10v, requires 347v option
EE1	eldoLED ECOdrive 1%, 0-10v Logarithmic
EE2	eldoLED ECOdrive 1%, 0-10v Linear
ES1	eldoLED SOLOdrive 0-10v, 0.1% Logarithmic
ES2	eldoLED SOLOdrive 0-10v, 0% Linear
OL5	Advance Xitanium 1%, 0-10v, AUX, Dim to Off
PL5	eldoLED Optotronic 1%, 0-10v, AUX , Dim to Off
DALI Drivers	
EE3	eldoLED ECOdrive 1%, DALI 2, Logarithmic, DT6
ES3	eldoLED SOLOdrive 0.1%, DALI 2, Logarithmic, DT6
OD1	eldoLED Optotronic 1%, DEXAL
EE4	eldoLED ECOdrive 1%, DALI 2, Linear, DT6
ES4	eldoLED SOLOdrive 0.1%, DALI 2, Linear, DT6
PR1	Advance Xitanium SR, DALI 2, Self powered link
Lutron Drivers	
LH1	Lutron Hi-lume Soft-on, Fade-to-black 1%, EcoSystem, LDE1
Alternate Drivers	
PS1	Signify Advance Xitanium Step Dimming 50%/100%
EH1	ELV 120v only, 0-10v universal

Driver: MOD Options

- Specify **MOD** in the part number for any of the below options
- MOD specifications are subject to longer lead-times. Consult factory for more information

MOD	Power Over Ethernet

How to Specify Circuiting, Battery and Emergency

1

- Select fixture circuiting from options below
- Some EX2D configurations will not accommodate all circuiting options, consult with factory
- Consult factory for Emergency (E) or Night Light (N) circuit with Tunable White (TW) option

Circuiting

1	Single Circuit
M	Multi Circuit
E	Emergency Circuit only
N	Night Light Circuit only

2 + **3**

- Battery and emergency section options are available in addition to fixture circuit
- Select battery and emergency section options below; factory shop drawing required
- Some EX2D configurations will not accommodate all circuiting options, consult with factory

Battery and/or Emergency *If Required*

0	No battery or specific emergency section required

Battery

- Select battery section type if required, indicate total QTY. *Example 2PL*
- 90 minute battery runtime; test button location dependent on configuration, consult factory
- No battery option available for 2' lengths
- Entire direct fixture housing is on battery for lengths up to 5'
- Half of direct fixture is on battery for 6' or 8' housing lengths
- For more battery options available, see Pinnacle Resource Guide
- For Tunable White (TW) option, battery with illuminate 6500K LED unless otherwise specified

0	No Battery
_FSB	Factory Select Battery (10w option)
_FSBST	Factory Select Battery (10w, Self Testing)
_PLL	Bodine 10w Integral Lithium, Self Testing
_ILL	Iota 10w Integral Lithium, Self Testing

For Approximate Battery Lumen Output

- Multiply battery wattage X fixture LPW shown on Lumen Table
- 92.3 (LPW) x 10 (watts) = 923 battery lumen output

Battery OR Emergency Ordering Examples

- Single circuit, 10w Integral Battery — Ordering Code: 1-1FSB
- Emergency only, 10w Integral Battery — Ordering Code: E-1PLL
- Single circuit, GTD required — Ordering Code: 1-1GB

Emergency

- Select emergency section type if required, indicate total QTY. *Example 1E*
- Combine battery and emergency section ordering codes if both options are selected
- Consult factory for Emergency Control Devices with Tunable White (TW) option

_FSG	Factory Select ALCR Emergency Control Device, UNV
_GI	Iota ETS-DR, Emergency Control Device, UNV
_GB	Bodine GTD, Emergency Control Device, 120v or 277v
_E	Emergency circuit section
_N	Night Light circuit section
_L	Life Safety circuit section NO THROUGH WIRE

Finish

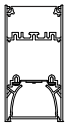
- Standard powder-coat textured white, metallic silver, textured black, graphite or bronze painted finish; consult factory for chip of standard paint finishes
- Selecting a fixture finish other than white may impact lumen output; consult factory for more information

W	White *(white cord/white canopy)*
S	Metallic Silver *(white cord/silver canopy)*
BL	Textured Black *(black cord/black canopy)*
BR	Bronze *(white cord/bronze canopy)*
GR	Graphite *(white cord/graphite canopy)*
CC	Custom Color *(white cord/color match canopy)*

Fixture Options

- Additional options to enhance the fixture and finish of the product

QS	Quick Ship
DSP	Customer Supplied Battery/Driver/Sensor
TC	Indirect Top Cover *(ac mounting only)*



*Cross section with TC Option

Fixture Options: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Remote Driver
	End Power Feed

Quick Ship

Shielding	CRI, CCT & Output	Mounting		Voltage		Driver		Circuiting		Battery		Finish	
10-Day													
A **HE** **BW** **WHE**	80 CRI, all color temperatures, all lumen packages *See pg 2*	**(M)AC48G_** **(M)AC48JB** **(M)AC48ST** **W** **S**	(M)AC to Grid (M)AC to J-BOX (M)AC to Structure Wall Mount Surface Mount	**U** **1** **2**	Universal (120-277) 120V 277V	**FSD**	Factory Select Driver *(1%, 0-10v)*	**1** **E** **N**	Single Circuit Emergency Night Light	**0** **_FSB**	None Factory Select Battery	**W** **S** **BL**	White Silver Black

All lengths and continuous rows up to 1,000 ft OR 150 individual fixtures. Black QuickShip only available in 4', 6', and 8' individual lengths. Consult factory for larger projects.

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Controls

- Pinnacle Lighting offers easy to specify network control solutions that connect to an intelligent centralized system to maximize lighting energy efficiencies or integral sensors for individual fixture control
- Pinnacle Lighting fixtures ship technology ready; commissioning by others
- Controls can only be used with Single Circuit (**1**) or Emergency Circuit (**E**)
- Contact factory for any non-standard configurations for layout, placement, or EM options
- One drop per sensor typical, consult factory for more information
- Consult factory for Controls with Tunable White (TW) option

	Solution	Components	Network/Sensor	Connection	Required Drivers	Limitation
DLMFC	Legrand Wattstopper DLM	LMFC-011	Digital Lighting Management (DLM)	Wired, one RJ45 ports	OL2, OL4	Not available with Battery
DLMFS	Legrand Wattstopper LLLC	LMFS-601-W / LMFI-111	Wireless DLM Fixture Sensor	Wireless	OD1, PR1, 0-10v	0-10v requires interface
EASYS	Philips EasySense	SNS-210	Daylight/PIR Occupancy	Wireless to switches	PR1	Not available with 347 volt
SNSLM	Encelium Sensilum	EN-CLM-PIR-DD-ZB	Encelium, Daylight/PIR Occupancy	Wireless	OD1, OL5	Not available with 347 volt
WLVX	Eaton Wavelinx	SWPD1, NSP3IVMVDC1	WaveLinx WCL, Daylight	Wireless	Any 0-10v	Not available with 347 volt
VDO	Lutron Vive Sensor	DFCSJ-OEM-OCC	Vive, Daylight/PIR Occupancy	Wireless	OD1, PR1	Not available with 347 volt
VRF	Lutron Vive Connected	DFCSJ-OEM-RF	Vive	Wireless	OD1, PR1	Not available with 347 volt
ENLI	Enlighted	SU-5E-IOT, CU-4E	Enlighted, Daylight/PIR Occupancy	Wireless	Any 0-10v	Not available with 347 volt
ENLC	Enlighted	SU-5E-CL, CU-4E	Enlighted, Daylight/PIR Occupancy	Wireless	Any 0-10v	Not available with 347 volt

Controls: MOD Options

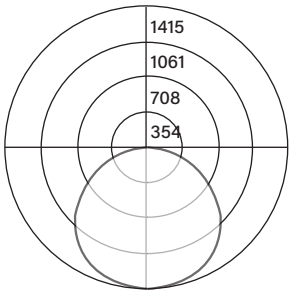
- Specify **MOD** in the part number for any of the below options
- **Control** Options may require specific driver. Refer to the chart below
- Consult factory for **MOD** specification details, pricing, and lead-time information

		Required Driver
MOD	Encelium Sensilum	OD1, OL5
	Enlighted (Wireless) - ENLI	Any 0-10v
	Enlighted (Wireless) - ENLC	Any 0-10v
	Acuity nLight Air Wireless Connected	EE6, ES6

Photometrics

Satine Lens

Test #	ITL91441
Catalog #	EX2D-A-840VHO-4
Lumens	3986 lm
Watts	37.5 W
Efficacy	106 LPW



Candela Distribution

Vert Angle	Horizontal Angle 0	22.5	45	67.5	90
0	1415	1415	1415	1415	1415
5	1410	1409	1408	1407	1406
10	1393	1387	1388	1387	1386
15	1365	1353	1356	1355	1352
20	1323	1307	1313	1312	1306
25	1271	1252	1258	1254	1249
30	1207	1187	1191	1187	1182
35	1132	1115	1117	1108	1103
40	1050	1032	1032	1023	1017
45	957	943	939	929	923
50	858	843	837	827	823
55	752	737	729	717	712
60	636	623	613	601	598
65	518	504	495	484	479
70	392	384	370	361	360
75	270	261	251	244	239
80	152	146	140	135	133
85	54	54	50	46	47
90	0	0	0	0	0

Luminance Data (cd/sq.m)

Angle In Degrees	Average 0-Deg	Average 45-Deg	Average 90-Deg
45	19610	19241	18913
55	18997	18416	17986
65	17760	16971	16422
75	15115	14052	13380
85	8977	8312	7814

For all available IES files, please visit our website at pinnacle-ltg.com. Photometry testing in accordance to IESNA-LM-79-08 at an NVLAP accredited testing laboratory. Testing conducted at 25°C ambient conditions.

Applications & Certificates

Construction: 6063-T6 Extruded aluminum housing. Highly reflective steel white painted reflector.

Shielding: Diffuse snap-in acrylic lens, removable for maintenance.

Mounting: Aircraft cable and wall mount available. Select from 2 aircraft cable options. Select the straight aircraft cable that mounts on 4'-0" (1219.2mm) and 8'-0" (2438.4mm) centers or the movable adjustable Y-cable mount. The Y-Cable design allows for adjustable mounting locations. Aircraft Cable supplied with 5" (127mm) power and 2" (50.8mm) non-power canopies. Refer to installation instructions for appropriate ceiling detail. Canopies are painted white unless otherwise specified. Maximum fixture weight is 20 lbs. for a standard 4' fixture.

White LED: 25°C test environment. Lumen output/wattage has a margin of +/- 5%; 2' or 3' lengths may have a greater wattage deviation. Luminaire configurations tested in accordance with IES LM-79. Diodes tested in accordance with IES LM-80. Lifetime calculated using IES TM-21. Minimum lifetime greater than 60,000 hours. TM-21-21 Lifetime Rating L70 = >72,000 hours, L90 = 69,700 hours. MacAdam 3-Step Ellipses. For all available IES files, please visit our website at pinnacle-ltg.com.

Tunable White LED: 2 channel solution with 2700K and 6500K LED, 90CRI only, R9 >50. Lumen packages available shown at 4000K CCT setpoint, lumen output varies based on CCT. Use multipliers for other CCT; 2700K = .91 3000K= .93 3500K=.97 4000K=1.0 5000K=1.044 6500K=1.078.

CRI, CCT & Output: Not all lumen packages available. Three lumen packages available. Standard, High (HO) and Very High (VHO). Custom outputs are available. Specify custom lumens or watts between standard offering listed on CRI, CCT & Output page. 80 CRI is available for 3000K, 3500K, and 4000K. 90 CRI is available for 2700K, 3000K, 3500K and 4000K. 90 CRI = R9≥50.

Voltage: Universal (U), 120 volt (1), 277 volt (2) and 347 volt (3) options available. Must specify PL4 or OL4 in Driver section when 347 volt (3) is selected. Some EDGE configurations will not accommodate all voltage options; consult with factory.

Driver: Standard Driver Option is Factory Select Driver 0-10V, 1% = FSD. Electronic driver, Power factor is >0.9 with a THD <20%. Driver Lifetime: 50,000 hours at 25°C ambient operating conditions. Ambient operating range: -20°F/-30°C to 122°F/50°C. For more driver options, see Pinnacle Resource Guide. Some EDGE configurations will not accommodate all driver options.

Circuiting: Select from single circuit (1), Multi circuit - For multiple circuiting and zone control, requires factory shop drawing (M), Emergency circuit (E), Life Safety (L) or Night Light circuit (N). For emergency circuiting situations that require no through wire or circuit separation, Life Safety Circuit should be selected. This will provide a separate power feed and only the Life Safety Circuit in that section. Some EDGE configurations will not accommodate all circuiting options; consult with factory.

Battery & Emergency: Select battery or emergency options if required. If battery or emergency option is not required, enter 0. Battery duration is 90 minutes as standard. Test button location dependent on configuration, consult factory. For more Battery options, see Pinnacle Resource Guide.

Finish: Standard powder-coat textured white, metallic silver, textured black, graphite or bronze painted finish; consult factory for chip of standard paint finishes or for additional custom color and finish options.

Controls: Standard options available, refer to Controls section table for available options, component part number(s), connection type, required driver and limitations. Mod options available, consult with factory.

Labels: UL and cUL 2108 or 1598 listed depending on product configuration. Standard, HO and VHO lumen packages are IC Rated, approved for dry/damp location unless otherwise noted.

Sustainability: All EDGE models are Living Building Challenge (LBC) Declared with third-party verification. The Declare Label from ILFI provides transparent insights into materials, sourcing, and environmental impact, promoting informed, sustainable choices that benefit both people and the planet. View the label here.

Fixture Weight: Maximum fixture weight is 20lbs per 4' fixture.

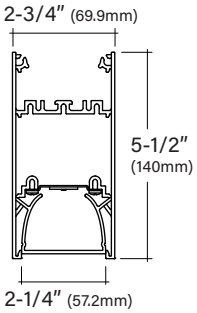
Buy American Act Compliant

Warranty: EDGE LED offered with a 5-year limited warranty. Covers LED, driver and fixture.

PINNACLE ARCHITECTURAL LIGHTING®

Project Name _____

Date _____ Type _____



EDGE EX2D

2" Suspended Direct Linear

Key Features

- 6063-T6 Extruded aluminum housing
- Room side maintenance for LED system
- 5-year limited warranty covers LED, driver and fixture
- ETL listed conforming to UL 1598 in US and CSA 250 in Canada
- Approved for dry/damp location unless otherwise noted
- Maximum weight is 20 lbs. for a standard 4' fixture
- Buy American Act compliant
- Run lengths available to an 1/8"
- Product transparency with third-party verified Living Building Challenge (LBC) Declared

Example Part #: EX2D-HE-N-830HO-26'-AC48G1-U-FSD-1-0-W

EX2D -	- N	-	-	-	-	-	-	-	-	-	-
DIRECT SHIELDING	*INDIRECT SHIELDING*	*SOURCE*	*LENGTH OR PATTERN*	*MOUNTING*	*VOLTAGE*	*DRIVER*	*CIRCUITING*	*BATTERY & EMERGENCY*	*FINISH*	*FIXTURE OPTIONS*	*CONTROLS*

__	N	_____	____
DIRECT SHIELDING	**INDIRECT SHIELDING**	**SOURCE** QS[1,2]	**LENGTH OR PATTERN**[3]
A - Satine Lens QS **AL** - Drop Lens **HE** - High Efficiency QS **BW** - Batwing QS **WHE** - Asymmetric QS **HED** - Descent *Shielding pg. 2*	**N** - None QS *Shielding pg. 2*	**_27__ -** 2700K **_30__ -** 3000K **_35__ -** 3500K **_40__ -** 4000K **TW __ -** 2CH Tunable White *(2700-6500K, 90CRI)* **CL_____ -** Custom Lumens **CW_____ -** Custom Watts **MOD** - Mod options available *Lumen Output pg. 2*	**__ -** Individual Fixture QS **__ -** Continuous Row QS **L _ x _ -** L Shape QS **R _ x _ -** Rectangle QS **S _ -** Square QS **U _ x _ x _ -** U-Shape QS **T _ x _ -** T Shape **X _ x _ x _ -** X Shape **MOD** - Mod options available *Length and Pattern pg. 3-4*

_____	_	___	_
MOUNTING	**VOLTAGE**[4]	**DRIVER**	**CIRCUITING**[5]
_AC_ _G_ - (M)AC to Grid QS **_AC_ _JB -** (M)AC to J Box QS **_AC_ _ST -** (M)AC to Structure QS **_AC5_ _G_ -** 5" Non-Power Canopy **_AC5_ _JB -** 5" Non-Power Canopy **_SQ_ _G_ -** 5" Square Canopy **_SQ_ _JB -** 5" Square Canopy **WA -** Wall Mount QS **S -** Surface Mount QS **MOD** - Mod options available *Mounting pg. 4*	**U -** Universal *(120 thru 277V)* QS **1 -** 120V QS **2 -** 277V QS **3 -** 347V *Voltage pg. 4*	**FSD -** Factory Select Driver *(1%, 0-10v)* QS **PL2 -** Advance Xitanium *(1%, 0-10v)* **OL2 -** eldoLED Optotronic *(1%, 0-10v)* **OL4 -** eldoLED Optotronic 347v *(1%, 0-10v)* **EE1 -** eldoLED ECOdrive *(1%, 0-10v)* **ES1 -** eldoLED SOLOdrive *(0.1%, 0-10v)* **LH1-** Lutron Hi-lume *(1%, EcoSystem)* **PR1 -** Advance Xitanium SR **MOD** - Mod options available *Driver pg. 5*	**1 -** Single Circuit QS **M -** Multi Circuit **E -** Emergency *(entire fixture)* QS **N -** Night Light *(entire fixture)* QS *Circuiting pg. 6*

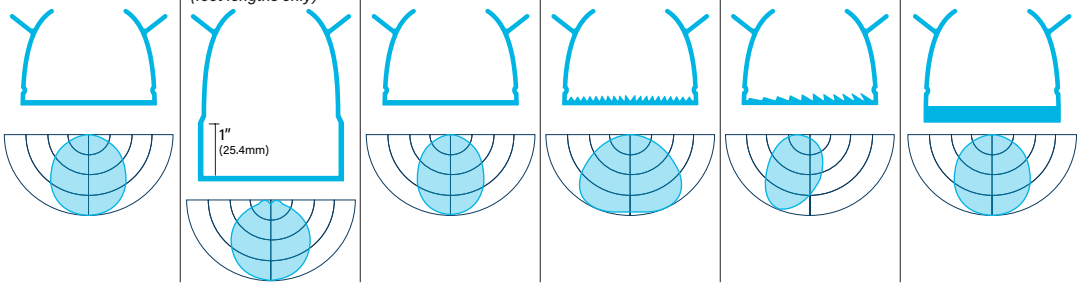
___	__	____	___
BATTERY & EMERGENCY[6]	**FINISH**	**FIXTURE OPTIONS**[7]	**CONTROLS**[8]
0 - None QS **_FSB** - Factory Select Battery QS **_FSG -** Factory Select ALCR **_GI** - Iota ETS DR **_GB** - Bodine GTD **_ILL -** Iota 10W **_PLL -** Bodine 10W **_E -** Emergency Section **_N -** Night Light Section **_L -** Life Safety Section *Battery and Emergency pg. 5-6*	**W -** White QS **S -** Metallic Silver QS **BL -** Textured Black QS **BR -** Bronze **GR -** Graphite **CC -** Custom Color *Finish pg. 6*	**QS -** QuickShip QS **TC -** Indirect Top Cover *(ac mounting only)* **DSP -** Customer Supplied Battery/Driver/Sensor **MOD** - Mod options available *Fixture Options pg. 6*	**DLMFC -** Wattstopper DLM *(wired)* **DLMFS -** Wattstopper LLLC *(wireless)* **EASYS -** Philips EasySense *(wireless)* **SNSLM -** Encelium Sensilum *(wireless)* **WVLX -** Eaton Wavelinx *(wireless)* **VDO -** Lutron Vive Sensor *(wireless)* **VRF -** Lutron Vive Connected *(wireless)* **ENL_ -** Enlighted *(wireless)* **MOD** - Mod options available *Controls pg. 7*

[1]When specifying SOURCE the first _ is for specifying either **8** - 80CRI, **9** - 90CRI. The ending __ are for specifying output, example 835HO - 80CRI, 3500K High Output. See output charts for more information. [2]When specifying Tunable White, use **TW** and then specify output, example TWHO - Tunable White 90CRI, High Output 2700-6500K. See output charts for more information. Tunable White option requires driver option **FSD** which provides separate 0-10v control leads for Intensity and CCT. [3]Individual fixtures come in **2', 3', 4', 5', 6', 7'** & **8'** lengths. Continuous row come in 1/8" increments. For Patterns specify pattern shape and overall dimensions. Example: L6x4: L pattern that is 6'x4'. [4]Specify AC Cable: Standard single AC = **AC** or Movable AC = **MAC**; Specify AC length standard AC is 48"; Specify grid: **G1**=15/16", **G9**=9/16", **GS**=Screw Slot. Example: AC48G1 [5]Tunable White (**TW**) option only available with Universal (**U**), 120V (**1**) or 277V (**2**) options. [6]Consult factory for Emergency (**E**) or Night Light (**N**) options with Tunable White (**TW**) option. [7]Enter quantity for Battery and Emergency, Example 2P. [8]When ordering QuickShip, **QS** must be used in fixture options section of part number to qualify. 1/8" increments not available for QS. [9]Controls can only be used with Single Circuit (**1**) or Emergency Circuit (**E**). See Controls chart on page 5 for driver options and more information.

Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

Direct Shielding

A	AL	HE	BW	WHE	HED
Satine Lens	Drop Lens *(foot lengths only)*	High Efficiency	Batwing	Asymmetric	Descent



Indirect Shielding

N
None

Source

- Specify either 80 or 90 CRI for White light LED
- Longer lead-time may apply for 90 CRI or Tunable White option. Consult factory
- Tunable White option requires driver option FSD which provides separate 0-10v control leads for Intensity and CCT.
- Tunable White lumen packages shown at 4000K CCT setpoint
- 90 CRI = R9≥50

Custom Output - Lumens OR Wattage

CL _____	Specify CRI, CCT and desired lumens (i.e. CL835500)	*Specify lumens between standard offering listed below. Lumens are specified per color temp*
CW _____	Specify CRI, CCT and desired wattage (i.e. CW9407)	*Specify watts between standard offering listed below*
CLTW_ _ _ _	Specify desired lumens for Tunable White (i.e. CLTW3200)	*Specify lumens between Tunable White offering listed below. Lumens are specified at 4000K CCT setpoint.*

80 CRI

	Color	Lumens per foot	Shielding[1] A Satine		AL Drop		HE High Efficiency		BW Batwing		WHE Asymmetric		HED Descent	
			LPW	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*	*LPW*	*Watts/ft*
830	3000K	500	101	4.9	101	4.9	119	4.2	119	4.2	116	4.3	98	5.1
830HO		750	101	7.4	103	7.3	119	6.3	119	6.3	116	6.5	99	7.6
830VHO		1000	103	9.8	105	9.5	122	8.2	122	8.2	119	8.4	99	10.1
835	3500K	500	102	4.9	105	4.8	123	4.1	123	4.1	120	4.2	101	5.0
835HO		750	104	7.2	107	7.0	123	6.1	123	6.1	120	6.3	101	7.5
835VHO		1000	106	9.4	107	9.3	126	8.0	126	7.9	123	8.2	102	9.8
840	4000K	500	102	4.9	105	4.8	123	4.1	123	4.1	120	4.2	101	5.0
840HO		750	104	7.2	107	7.0	123	6.1	123	6.1	120	6.3	101	7.5
840VHO		1000	106	9.4	107	9.3	126	8.0	126	7.9	123	8.2	102	9.8

90 CRI

927	2700K	500	82	6.1	83	6.0	99	5.1	99	5.1	96	5.2	79	6.4
927HO		750	84	9.0	85	8.8	98	7.6	99	7.6	98	7.7	80	9.3
927VHO		1000	82	12.2	83	12.0	100	10.0	100	10.0	97	10.3	79	12.7
930	3000K	500	89	5.6	91	5.5	105	4.7	106	4.7	103	4.9	86	5.8
930HO		750	91	8.3	93	8.1	108	7.0	108	7.0	105	7.1	88	8.5
930VHO		1000	90	11.1	92	10.8	108	9.3	108	9.2	107	9.4	86	11.6
935	3500K	500	89	5.6	91	5.5	105	4.8	105	4.8	103	4.9	86	5.8
935HO		750	90	8.3	92	8.1	107	7.0	107	7.0	105	7.2	88	8.6
935VHO		1000	90	11.1	92	10.9	108	9.3	108	9.3	106	9.4	86	11.7
940	4000K	500	89	5.6	91	5.5	105	4.8	105	4.8	103	4.9	86	5.8
940HO		750	90	8.3	92	8.1	107	7.0	107	7.0	105	7.2	88	8.6
940VHO		1000	90	11.1	92	10.9	108	9.3	108	9.3	106	9.4	86	11.7

2 CH Tunable White (2700-6500K, 90CRI)

TW	2700 - 6500K	500	79.0	6.3	N/A	95.8	5.2	93.9	5.4	93.3	5.4	N/A
TWHO		750	74.9	10.0		92.9	8.1	89.9	8.3	89.9	8.3	
TWVHO		1000	N/A			N/A		N/A		N/A		

Direct Source: MOD Options

- Specify **MOD** in the part number for any of the below options
- All RGB_ Source Options will require specific driver and control
- Consult factory for **MOD** specification details, pricing, and lead-time information

		Required Driver	Required Control
MOD	Color Changing RGB LED	EC1/EC4	DMX
	Color Changing RGB-W LED	EC1/EC4	DMX

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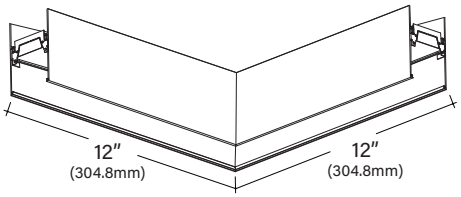
Length

- For Continuous Runs, add 3/16″ (4.7mm) for each end plate or 3/8″ (9.5mm) to the overall length of the row

2	3	4	5	6	7	8	–
Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Indiv. Fixture	Cont. Run *Specify nominal overall row length to the 1/8″ Longer lead-time may apply for lengths to the 1/8″. Consult factory.*

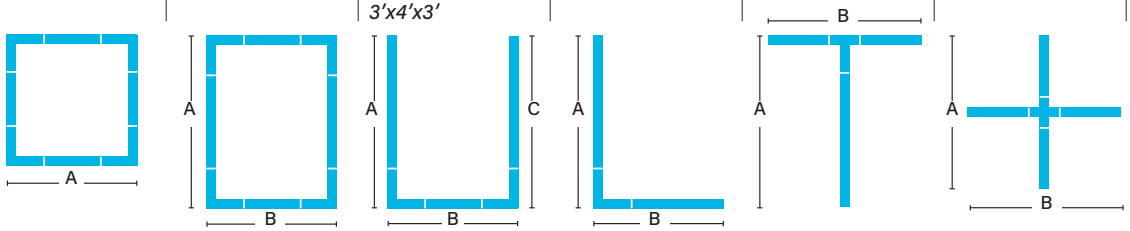
- 24-3/8″ (619.1mm)
- 36-3/8″ (934.8mm)
- 48-3/8″ (1228.7mm)
- 60-3/8″ (1533.5mm)
- 72-3/8″ (1838.3mm)
- 84-3/8″ (2143.1mm)
- 96-3/8″ (2447.9mm)
- Specify to the 1/8″

Pattern



- Specify pattern shape and overall dimensions (includes corner dimensions)
- Refer to dimensions table below for available standard lengths
- All connectors are direct only
- 90 degree horizontal corners are 12″x12″ (overall, outside dimension)
- Angles and shapes not shown require Mod Pattern; consult factory
- Only available with "A" or "HE" lens options

S_	R_x_	U_x_x_	L_x_	T_x_	X_x_	M
Square *Provide A dimension Example:* **S4′** *Minimum Length- 4′x4′*	Rectangle *Provide AxB dimensions Example:* **R4′x4′** *Minimum Length- 4′x4′*	U-Shape *Provide AxBxC dimensions Example:* **U3′x4′x3′** *Minimum Length- 3′x4′x3′*	L-Shape *Provide AxB dimensions Example:* **L3′x3′** *Minimum Length- 3′x3′*	T-Shape *Provide AxB dimensions Example:* **T3′x5′** *Minimum Length- 3′x5′*	X-Shape *Provide AxB dimensions Example:* **X5′x5′** *Minimum Length- 5′x5′*	Mod Layout *For patterns or lengths not shown or standard*

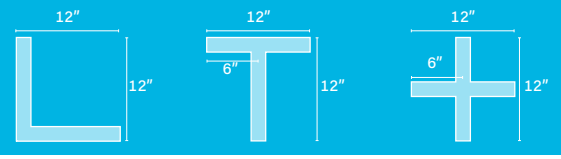


Length or Pattern: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Specify MOD for patterns, lengths or angles not shown above
	45- 180 degree angles
	Single-piece welded housings up to 4′ x 4′

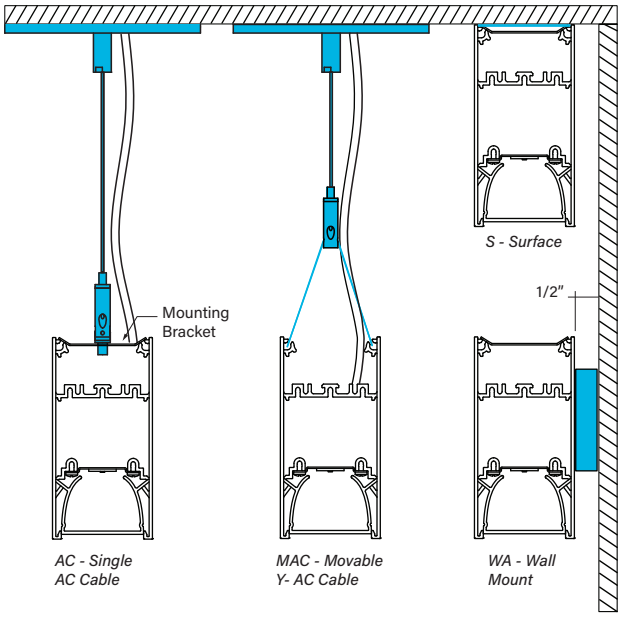
Horizontal Details: Every Connection is 12″ x 12″ in Overall Dimension



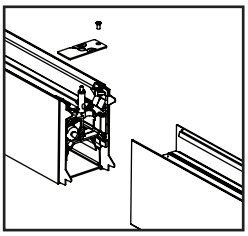
Mounting

- Specify cable length in ordering code (AC48G1)
- Standard adjustable cable. Specify 48", 120", 240" or 350"
- End plates and power cord attached at factory
- Aircraft cable (AC) mounts on 4' (1219.2mm) and 8' (2438.4mm) centers
- Maximum recommended movable mounting locations are 12" from end of 4' fixture and 18" from end of 8' fixture
- AC Cable supplied with 5" (127mm) power and 2" (50.8mm) non-power canopies
- Canopies and pendants match fixture finish, power cords are white or black depending on fixture finish. See Finish section for additional details.
- Approved for dry/damp location unless otherwise noted
- Refer to installation instructions during installation at the job site
- Maximum fixture weight is 20 lbs for a standard 4' fixture
- Top Cover is optional on AC mounting fixtures, Top Cover is standard on others

AC__G1	Aircraft Cable 1" (15/16") T-Bar
AC__G9	Aircraft Cable 9/16" T-Bar
AC__GS	Aircraft Cable Screw Slot T-Bar
AC__JB	Aircraft Cable Junction Box
AC__ST	Aircraft Cable Structure
AC5__G_	Aircraft Cable 5" (127mm) Non-Power Canopy
AC5__JB	Aircraft Cable 5" (127mm) Non-Power Canopy
SQ__G_	Aircraft Cable 5" (127mm) Square Canopy
SQ__JB	Aircraft Cable 5" (127mm) Square Canopy
MAC__G1	Movable AC 1" (15/16") T-Bar
MAC__G9	Movable AC 9/16" T-Bar
MAC__GS	Movable AC Screw Slot T-Bar
MAC__JB	Movable AC Junction Box
MAC__ST	Movable AC Structure
MAC5__G_	Movable AC 5" (127mm) Non-Power Canopy
MAC5__JB	Movable AC 5" (127mm) Non-Power Canopy
MSQ__G_	Movable AC 5" (127mm) Square Canopy
MSQ__JB	Movable AC 5" (127mm) Square Canopy
WA	Wall Mount
S	Surface Mount



Straight EDGE Joint System



- The Straight EDGE Joint comes standard for all runs.
- Two connection points – one to cinch fixtures together, the other to perfectly align all fixtures in a run.
- Factory-installed light shields on both sides of the fixture ensure no light leaks.
- Patented.

Mounting: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Recessed to Suspended
	Pendant Pipe

Voltage

- Some EX2D configurations will not accommodate all voltage options; consult with factory
- 347 volt not available with Tunable White (TW) option

U	Universal
1	120 volt
2	277 volt
3	347 volt

Driver

- Standard Driver Option = FSD
- Driver Lifetime: 50,000 hours at 25°C ambient operating conditions
- For more driver options see Pinnacle Resource Guide
- Some EX2D configurations will not accommodate all driver options; consult with factory

0-10V Drivers	
FSD	Factory Select Driver 1%, 0-10v
PL2	Signify Advance Xitanium 1%, 0-10v
PL4	Advance Xitanium 347v 1%, 0-10v, requires 347v
OL2	eldoLED Optotronic, 1%, 0-10v
OL4	eldoLED Optotronic 347v, 1% 0-10v, requires 347v option
EE1	eldoLED ECOdrive 1%, 0-10v Logarithmic
EE2	eldoLED ECOdrive 1%, 0-10v Linear
ES1	eldoLED SOLOdrive 0-10v, 0.1% Logarithmic
ES2	eldoLED SOLOdrive 0-10v, 0% Linear
OL5	Advance Xitanium 1%, 0-10v, AUX, Dim to Off
PL5	eldoLED Optotronic 1%, 0-10v, AUX , Dim to Off
DALI Drivers	
EE3	eldoLED ECOdrive 1%, DALI 2, Logarithmic, DT6
ES3	eldoLED SOLOdrive 0.1%, DALI 2, Logarithmic, DT6
OD1	eldoLED Optotronic 1%, DEXAL
EE4	eldoLED ECOdrive 1%, DALI 2, Linear, DT6
ES4	eldoLED SOLOdrive 0.1%, DALI 2, Linear, DT6
PR1	Advance Xitanium SR, DALI 2, Self powered link
Lutron Drivers	
LH1	Lutron Hi-lume Soft-on, Fade-to-black 1%, EcoSystem, LDE1
Alternate Drivers	
PS1	Signify Advance Xitanium Step Dimming 50%/100%
EH1	ELV 120v only, 0-10v universal

Driver: MOD Options

- Specify **MOD** in the part number for any of the below options
- MOD specifications are subject to longer lead-times. Consult factory for more information

MOD	Power Over Ethernet

How to Specify Circuiting, Battery and Emergency

1

- Select fixture circuiting from options below
- Some EX2D configurations will not accommodate all circuiting options, consult with factory
- Consult factory for Emergency (E) or Night Light (N) circuit with Tunable White (TW) option

Circuiting

1	Single Circuit
M	Multi Circuit
E	Emergency Circuit only
N	Night Light Circuit only

2 + **3**

- Battery and emergency section options are available in addition to fixture circuit
- Select battery and emergency section options below; factory shop drawing required
- Some EX2D configurations will not accommodate all circuiting options, consult with factory

Battery and/or Emergency *If Required*

0	No battery or specific emergency section required

Battery

- Select battery section type if required, indicate total QTY. *Example 2PL*
- 90 minute battery runtime; test button location dependent on configuration, consult factory
- No battery option available for 2' lengths
- Entire direct fixture housing is on battery for lengths up to 5'
- Half of direct fixture is on battery for 6' or 8' housing lengths
- For more battery options available, see Pinnacle Resource Guide
- For Tunable White (TW) option, battery with illuminate 6500K LED unless otherwise specified

0	No Battery
_FSB	Factory Select Battery (10w option)
_FSBST	Factory Select Battery (10w, Self Testing)
_PLL	Bodine 10w Integral Lithium, Self Testing
_ILL	Iota 10w Integral Lithium, Self Testing

For Approximate Battery Lumen Output

- Multiply battery wattage X fixture LPW shown on Lumen Table
- 92.3 (LPW) x 10 (watts) = 923 battery lumen output

Battery OR Emergency Ordering Examples

- Single circuit, 10w Integral Battery — Ordering Code: 1-1FSB
- Emergency only, 10w Integral Battery — Ordering Code: E-1PLL
- Single circuit, GTD required — Ordering Code: 1-1GB

Emergency

- Select emergency section type if required, indicate total QTY. *Example 1E*
- Combine battery and emergency section ordering codes if both options are selected
- Consult factory for Emergency Control Devices with Tunable White (TW) option

_FSG	Factory Select ALCR Emergency Control Device, UNV
_GI	Iota ETS-DR, Emergency Control Device, UNV
_GB	Bodine GTD, Emergency Control Device, 120v or 277v
_E	Emergency circuit section
_N	Night Light circuit section
_L	Life Safety circuit section NO THROUGH WIRE

Finish

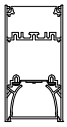
- Standard powder-coat textured white, metallic silver, textured black, graphite or bronze painted finish; consult factory for chip of standard paint finishes
- Selecting a fixture finish other than white may impact lumen output; consult factory for more information

W	White *(white cord/white canopy)*
S	Metallic Silver *(white cord/silver canopy)*
BL	Textured Black *(black cord/black canopy)*
BR	Bronze *(white cord/bronze canopy)*
GR	Graphite *(white cord/graphite canopy)*
CC	Custom Color *(white cord/color match canopy)*

Fixture Options

- Additional options to enhance the fixture and finish of the product

QS	Quick Ship
DSP	Customer Supplied Battery/Driver/Sensor
TC	Indirect Top Cover *(ac mounting only)*



*Cross section with TC Option

Fixture Options: MOD Options

- Specify **MOD** in the part number for any of the below options
- Consult factory for **MOD** specification details, pricing, and lead-time information

MOD	Remote Driver
	End Power Feed

Quick Ship

Shielding	CRI, CCT & Output	Mounting		Voltage		Driver		Circuiting		Battery		Finish	
10-Day													
A **HE** **BW** **WHE**	80 CRI, all color temperatures, all lumen packages *See pg 2*	**(M)AC48G_** **(M)AC48JB** **(M)AC48ST** **W** **S**	(M)AC to Grid (M)AC to J-BOX (M)AC to Structure Wall Mount Surface Mount	**U** **1** **2**	Universal (120-277) 120V 277V	**FSD**	Factory Select Driver *(1%, 0-10v)*	**1** **E** **N**	Single Circuit Emergency Night Light	**0** **_FSB**	None Factory Select Battery	**W** **S** **BL**	White Silver Black

All lengths and continuous rows up to 1,000 ft OR 150 individual fixtures. Black QuickShip only available in 4', 6', and 8' individual lengths. Consult factory for larger projects.

Specifications and dimensions subject to change without notice. Specification sheets that appear on pinnacle-ltg.com are the most recent version and supersede all other previously printed or electronic versions.

Controls

- Pinnacle Lighting offers easy to specify network control solutions that connect to an intelligent centralized system to maximize lighting energy efficiencies or integral sensors for individual fixture control
- Pinnacle Lighting fixtures ship technology ready; commissioning by others
- Controls can only be used with Single Circuit (**1**) or Emergency Circuit (**E**)
- Contact factory for any non-standard configurations for layout, placement, or EM options
- One drop per sensor typical, consult factory for more information
- Consult factory for Controls with Tunable White (TW) option

	Solution	Components	Network/Sensor	Connection	Required Drivers	Limitation
DLMFC	Legrand Wattstopper DLM	LMFC-011	Digital Lighting Management (DLM)	Wired, one RJ45 ports	OL2, OL4	Not available with Battery
DLMFS	Legrand Wattstopper LLLC	LMFS-601-W / LMFI-111	Wireless DLM Fixture Sensor	Wireless	OD1, PR1, 0-10v	0-10v requires interface
EASYS	Philips EasySense	SNS-210	Daylight/PIR Occupancy	Wireless to switches	PR1	Not available with 347 volt
SNSLM	Encelium Sensilum	EN-CLM-PIR-DD-ZB	Encelium, Daylight/PIR Occupancy	Wireless	OD1, OL5	Not available with 347 volt
WLVX	Eaton Wavelinx	SWPD1, NSP3IVMVDC1	WaveLinx WCL, Daylight	Wireless	Any 0-10v	Not available with 347 volt
VDO	Lutron Vive Sensor	DFCSJ-OEM-OCC	Vive, Daylight/PIR Occupancy	Wireless	OD1, PR1	Not available with 347 volt
VRF	Lutron Vive Connected	DFCSJ-OEM-RF	Vive	Wireless	OD1, PR1	Not available with 347 volt
ENLI	Enlighted	SU-5E-IOT, CU-4E	Enlighted, Daylight/PIR Occupancy	Wireless	Any 0-10v	Not available with 347 volt
ENLC	Enlighted	SU-5E-CL, CU-4E	Enlighted, Daylight/PIR Occupancy	Wireless	Any 0-10v	Not available with 347 volt

Controls: MOD Options

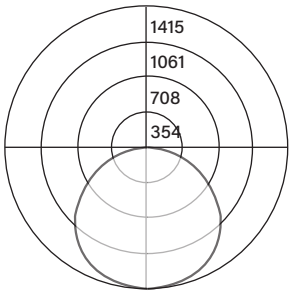
- Specify **MOD** in the part number for any of the below options
- **Control** Options may require specific driver. Refer to the chart below
- Consult factory for **MOD** specification details, pricing, and lead-time information

		Required Driver
MOD	Encelium Sensilum	OD1, OL5
	Enlighted (Wireless) - ENLI	Any 0-10v
	Enlighted (Wireless) - ENLC	Any 0-10v
	Acuity nLight Air Wireless Connected	EE6, ES6

Photometrics

Satine Lens

Test #	ITL91441
Catalog #	EX2D-A-840VHO-4
Lumens	3986 lm
Watts	37.5 W
Efficacy	106 LPW



Candela Distribution

Vert Angle	Horizontal Angle 0	22.5	45	67.5	90
0	1415	1415	1415	1415	1415
5	1410	1409	1408	1407	1406
10	1393	1387	1388	1387	1386
15	1365	1353	1356	1355	1352
20	1323	1307	1313	1312	1306
25	1271	1252	1258	1254	1249
30	1207	1187	1191	1187	1182
35	1132	1115	1117	1108	1103
40	1050	1032	1032	1023	1017
45	957	943	939	929	923
50	858	843	837	827	823
55	752	737	729	717	712
60	636	623	613	601	598
65	518	504	495	484	479
70	392	384	370	361	360
75	270	261	251	244	239
80	152	146	140	135	133
85	54	54	50	46	47
90	0	0	0	0	0

Luminance Data (cd/sq.m)

Angle In Degrees	Average 0-Deg	Average 45-Deg	Average 90-Deg
45	19610	19241	18913
55	18997	18416	17986
65	17760	16971	16422
75	15115	14052	13380
85	8977	8312	7814

For all available IES files, please visit our website at pinnacle-ltg.com. Photometry testing in accordance to IESNA-LM-79-08 at an NVLAP accredited testing laboratory. Testing conducted at 25°C ambient conditions.

Applications & Certificates

Construction: 6063-T6 Extruded aluminum housing. Highly reflective steel white painted reflector.

Shielding: Diffuse snap-in acrylic lens, removable for maintenance.

Mounting: Aircraft cable and wall mount available. Select from 2 aircraft cable options. Select the straight aircraft cable that mounts on 4'-0" (1219.2mm) and 8'-0" (2438.4mm) centers or the movable adjustable Y-cable mount. The Y-Cable design allows for adjustable mounting locations. Aircraft Cable supplied with 5" (127mm) power and 2" (50.8mm) non-power canopies. Refer to installation instructions for appropriate ceiling detail. Canopies are painted white unless otherwise specified. Maximum fixture weight is 20 lbs. for a standard 4' fixture.

White LED: 25°C test environment. Lumen output/wattage has a margin of +/- 5%; 2' or 3' lengths may have a greater wattage deviation. Luminaire configurations tested in accordance with IES LM-79. Diodes tested in accordance with IES LM-80. Lifetime calculated using IES TM-21. Minimum lifetime greater than 60,000 hours. TM-21-21 Lifetime Rating L70 = >72,000 hours, L90 = 69,700 hours. MacAdam 3-Step Ellipses. For all available IES files, please visit our website at pinnacle-ltg.com.

Tunable White LED: 2 channel solution with 2700K and 6500K LED, 90CRI only, R9 >50. Lumen packages available shown at 4000K CCT setpoint, lumen output varies based on CCT. Use multipliers for other CCT; 2700K = .91 3000K= .93 3500K=.97 4000K=1.0 5000K=1.044 6500K=1.078.

CRI, CCT & Output: Not all lumen packages available. Three lumen packages available. Standard, High (HO) and Very High (VHO). Custom outputs are available. Specify custom lumens or watts between standard offering listed on CRI, CCT & Output page. 80 CRI is available for 3000K, 3500K, and 4000K. 90 CRI is available for 2700K, 3000K, 3500K and 4000K. 90 CRI = R9≥50.

Voltage: Universal (U), 120 volt (1), 277 volt (2) and 347 volt (3) options available. Must specify PL4 or OL4 in Driver section when 347 volt (3) is selected. Some EDGE configurations will not accommodate all voltage options; consult with factory.

Driver: Standard Driver Option is Factory Select Driver 0-10V, 1% = FSD. Electronic driver, Power factor is >0.9 with a THD <20%. Driver Lifetime: 50,000 hours at 25°C ambient operating conditions. Ambient operating range: -20°F/-30°C to 122°F/50°C. For more driver options, see Pinnacle Resource Guide. Some EDGE configurations will not accommodate all driver options.

Circuiting: Select from single circuit (1), Multi circuit - For multiple circuiting and zone control, requires factory shop drawing (M), Emergency circuit (E), Life Safety (L) or Night Light circuit (N). For emergency circuiting situations that require no through wire or circuit separation, Life Safety Circuit should be selected. This will provide a separate power feed and only the Life Safety Circuit in that section. Some EDGE configurations will not accommodate all circuiting options; consult with factory.

Battery & Emergency: Select battery or emergency options if required. If battery or emergency option is not required, enter 0. Battery duration is 90 minutes as standard. Test button location dependent on configuration, consult factory. For more Battery options, see Pinnacle Resource Guide.

Finish: Standard powder-coat textured white, metallic silver, textured black, graphite or bronze painted finish; consult factory for chip of standard paint finishes or for additional custom color and finish options.

Controls: Standard options available, refer to Controls section table for available options, component part number(s), connection type, required driver and limitations. Mod options available, consult with factory.

Labels: UL and cUL 2108 or 1598 listed depending on product configuration. Standard, HO and VHO lumen packages are IC Rated, approved for dry/damp location unless otherwise noted.

Sustainability: All EDGE models are Living Building Challenge (LBC) Declared with third-party verification. The Declare Label from ILFI provides transparent insights into materials, sourcing, and environmental impact, promoting informed, sustainable choices that benefit both people and the planet. View the label here.

Fixture Weight: Maximum fixture weight is 20lbs per 4' fixture.

Buy American Act Compliant

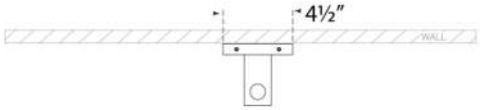
Warranty: EDGE LED offered with a 5-year limited warranty. Covers LED, driver and fixture.

TEAR SHEET

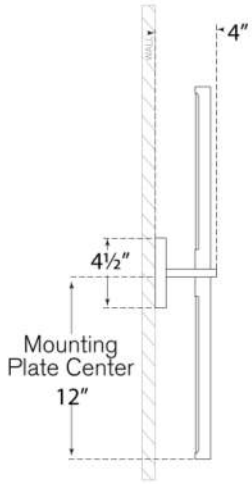
Axis Large Linear Sconce
Item # KW 2736AB

Designer: Kelly Wearstler

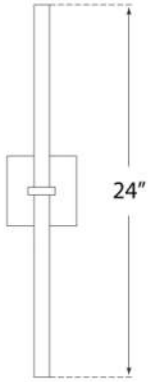
Height: 24"
Width: 4.5"
Extension: 4"
Backplate: 4.5" Square
Finishes: AB, BZ, PN
Lightsource: Dedicated LED
Wattage: 20w (2400lm)
Weight: 4 Pounds



Top View



Side View



Front View

VISUAL COMFORT & CO.

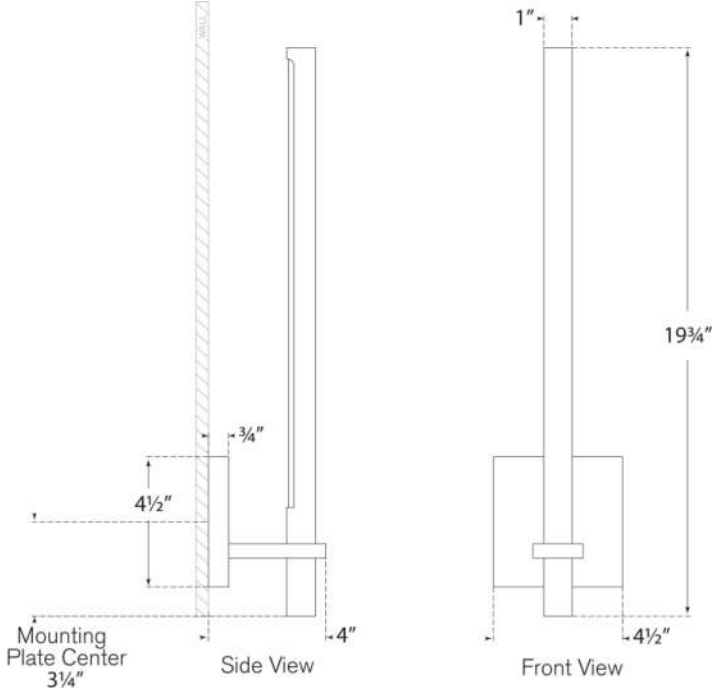
DAMP LED 4

TEAR SHEET

Axis Medium Sconce
Item # KW 2735AB

Designer: Kelly Wearstler

Height: 19.75"
Width: 4.5"
Extension: 4"
Backplate: 4.5" Square
Finishes: AB, BZ, PN
Lightsource: Dedicated LED
Wattage: 15w (1200lm)
Weight: 3 Pounds



VISUAL COMFORT & CO.

DAMP LED 4

WAC LIGHTING

Corkscrew

Pendant 4CCT

Fixture Type:

Catalog Number:

Project:

Location:

Model & Size	Color Temp	Finish	LED Watts	LED Lumens	Delivered Lumens
❍ PD-39443 43"	❍ 2700K ❍ 3000K ❍ 3500K ❍ 4000K	❍ BK Black	38 W	2862	1785

Example: **PD-39443-40-BK**
For custom requests please contact customs@waclighting.com

DESCRIPTION

A playful band of light spirals around a linear bar. This looped structure delivers artful style along with a soft layer of multi-directional illumination.

FEATURES

• Low profile, adjustable powered aircraft cables for an ultra-clean look
• May be mounted on slope ceiling
• Built in color temperature adjustability. Switch from 2700K/3000K/3500K/4000K
• Rectangular canopy with minimal hardware
• Driver concealed within the canopy

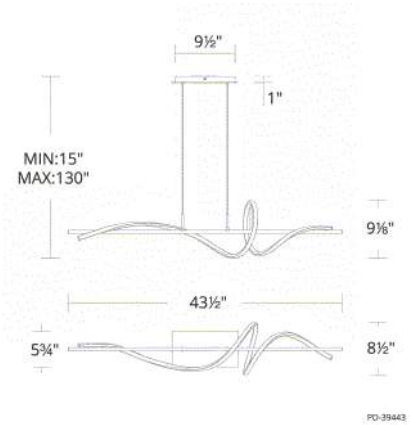
SPECIFICATIONS

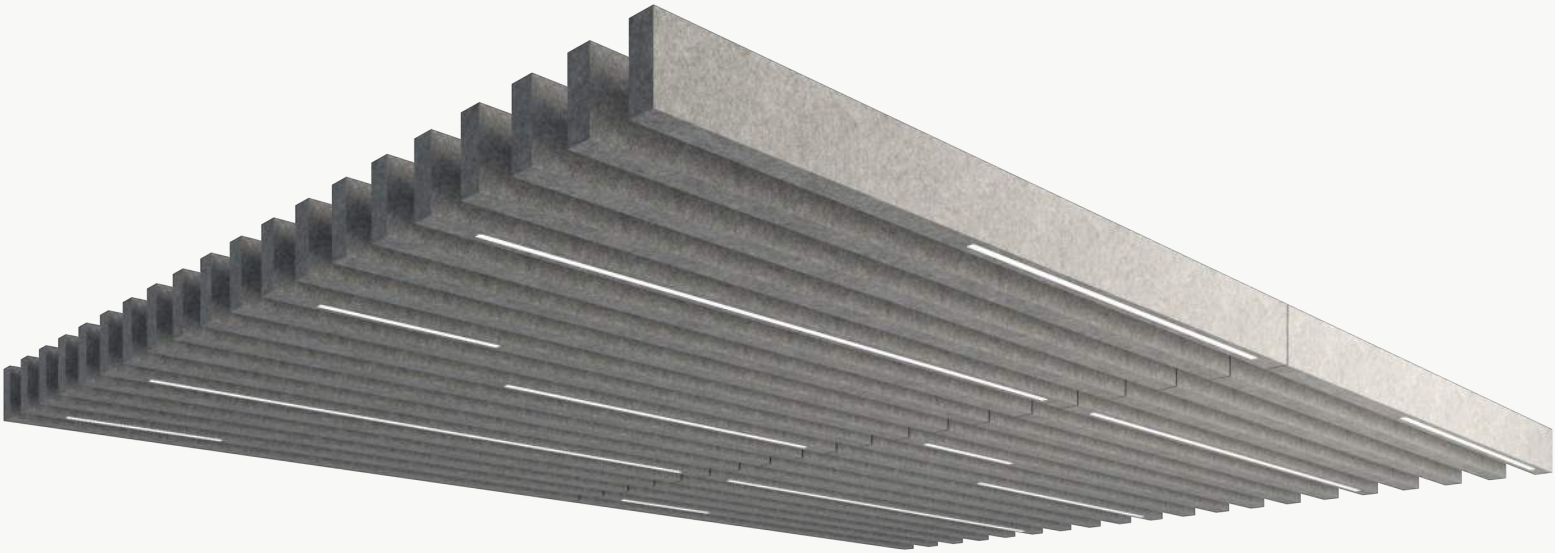
Color Temp:	2700K,3000K,3500K,4000K
Input:	120-277V,50/60Hz
CRI	90
Dimming:	ELV: 100-10% , TRIAC: 100-5%
Rated Life:	50,000 Hours
Standards:	ETL, cETL, Damp Location Listed
Construction	Aluminum body, silicone diffuser

FINISHES:

Black

LINE DRAWING





CSI Creative

FOLDED BAFFLES 008

BFL-FLD-008

Product Specifications

Product Name	Folded Baffles 008
Product ID	BFL-FLD-008
Acoustics	0.75 - 0.95 NRC*
Lead Time	Lead time is dependent on project size. Contact us for more information.
Durability	Contract
Warranty	Comes with industry-leading standard warranty.
Flammability	ASTM E84: Class A
Custom	Custom colors and manufacturing services available. Additional charges and lead times may apply.
Maintenance	Vacuum occasionally to remove airborne dust or debris. Mild detergents or soaps may be used to remove stains. For detailed care instructions, refer to the **CSI Creative Maintenance Information** document.

Material Specifications

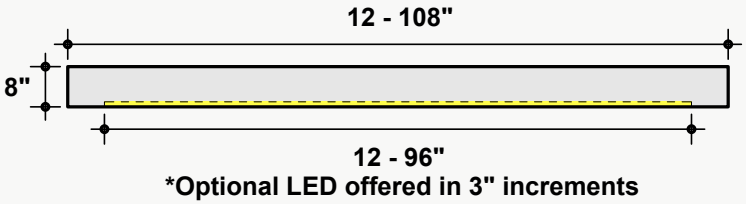
	Soundcore®
Content	Recycled PET acoustic felt
Weathering	Colorfast, non-deteriorating, non-hygroscopic
Environmental	Recycled PET acoustic felt is 60% post-consumer recycled content and is 100% recyclable. Contributes points toward LEED v4. CDPH v1.2, VOC free, non-toxic, non-allergenic, anti-microbial - does not attract mold and mildew. Compliant with Living Building Challenge criteria & DECLARE Red List Free.
Variation	PET felt panels are created through a manufacturing process known as 'felting'. This process results in a heathered appearance. Multiple color tones may appear in the same panel. Slight color variations should be expected.

*Approximate. NRC rating may vary due to product dimensions and spacing.

Dimensions

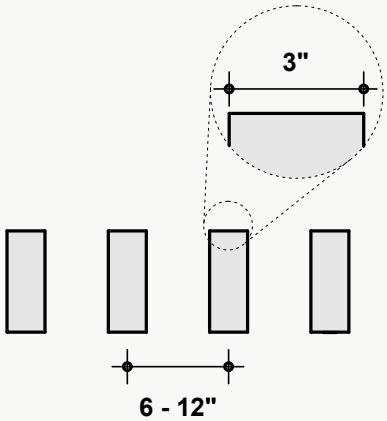
Standard Unit Dimensions

Typical ranges for length and height.



Standard Unit Thicknesses

Thickness is independent of material layer selection.



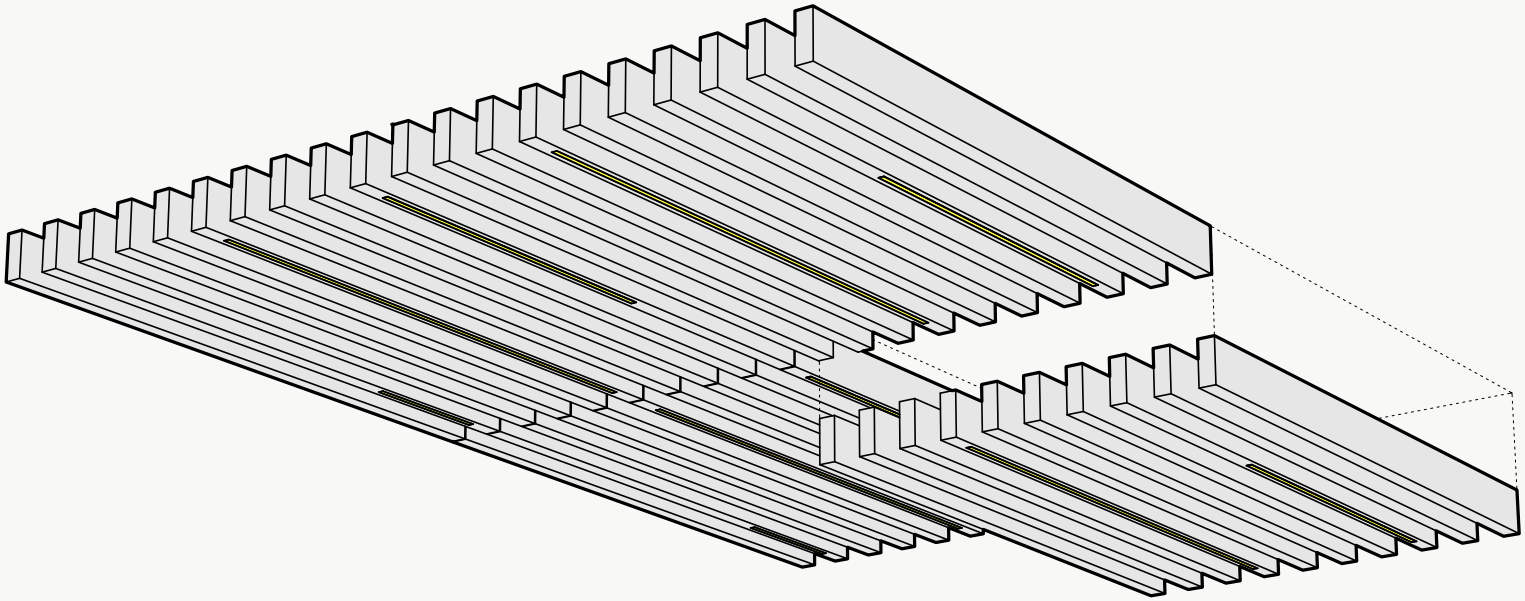
Custom Opportunity

Product dimensions can be manipulated in order to fit your design aesthetic and site conditions.

On-Center Spacing

Our standard product spacing is 6”-12” on-center. Acoustic performance of the product improves as spacing is reduced.

Product Details



MAXIMUM LENGTH FOR LED STRIP TAPE PER MAX WATTAGE

DRIVER		LUMEN PACKAGE					
WATTAGE	MAXIMUM LOAD	LP0 1.5 W/ft 119 lm/ft 390 lm/m	LP1 1.5 W/ft 137 lm/ft 450 lm/m	LP2 2.9 W/ft 234 lm/ft 768 lm/m	LP3 4.4 W/ft 335 lm/ft 1100 lm/m	LP4 5.8 W/ft 488 lm/ft 1600 lm/m	LHP 7 W/ft 450 lm/ft 2190 lm/m
25 watts POWER SUPPLY / DRIVER	**20 watts**	13'8"	13'8"	6'10"	4'6"	3'5"	2'10"
		4.17 meters	4.17 meters	2.08 meters	1.38 meters	1.04 meters	0.87 meters
50 watts POWER SUPPLY / DRIVER	**40 watts**	27'4"	27'4"	13'8"	9'1"	6'10"	5'8"
		8.33 meters	8.33 meters	4.17 meters	2.76 meters	2.08 meters	1.74 meters
60 watts POWER SUPPLY / DRIVER	**48 watts**	32'10"	32'10"	16'5"	10'10"	8'2"	6'10"
		10.00 meters	10.00 meters	5.00 meters	3.31 meters	2.50 meters	2.09 meters
96 watts POWER SUPPLY / DRIVER	**77 watts**	52'7" *	52'7" *	26'4"	17'5"	13'2"	10'11"
		16.04 meters *	16.04 meters *	8.02 meters	5.31 meters	4.01 meters	3.35 meters
100 watts POWER SUPPLY / DRIVER	**80 watts**	54'8" *	54'8" *	27'4"	18'1"	13'8"	11'5"
		16.67 meters *	16.67 meters *	8.33 meters	5.52 meters	4.17 meters	3.48 meters

To adhere to LED driver Class 2 limits as defined by the US National Electrical Code (NEC) and the Canadian Electrical Code (CEC), 12Vdc permits a maximum of 5 amps (60W) and 24Vdc permits a maximum of 4 amps (96W) per driver.

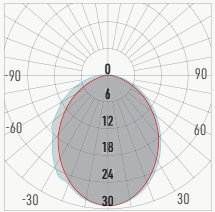
* Total length for two or more strips. To minimize the the voltage drop on a single led tape run, we won't exceed 10 meters or 33 feet on one consecutive length of strip.

Lighting Specs

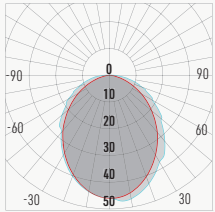
Lighting Fixture Features:

+ Square profile: 0.93” x 1.00”
+ UL Certified
+ ALCOA 6063 - T5 Aluminum Alloy

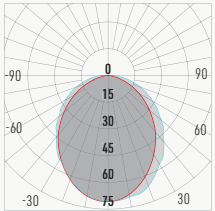
98° (average) - Performance Per 1” - Tested at 4200K, 90+ CRI



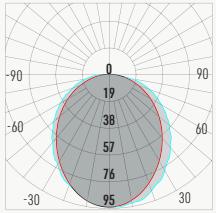
LP1			
CCT	3000K	3500K	4200K
Watts	1.5	1.5	1.5
Lumen	65	65	68
Lumen / W	41	41	43
Ratio	0.95	0.96	1.00



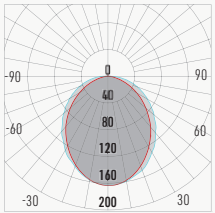
LP2			
CCT	3000K	3500K	4200K
Watts	2.9	2.9	2.9
Lumen	105	106	110
Lumen / W	40	40	42
Ratio	0.95	0.96	1.00



LP3			
CCT	3000K	3500K	4200K
Watts	4.4	4.4	4.4
Lumen	163	165	172
Lumen / W	41	41	43
Ratio	0.95	0.96	1.00



LP4			
CCT	3000K	3500K	4200K
Watts	5.4	5.4	5.4
Lumen	245	248	258
Lumen / W	45	46	48
Ratio	0.95	0.96	1.00



LHP			
CCT	3000K	3500K	4200K
Watts	7.0	7.0	7.0
Lumen	388	392	408
Lumen / W	51	52	54
Ratio	0.95	0.96	1.00

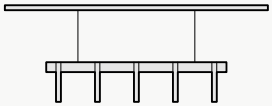
Installation Options

*All products and installation methods can be **customized** to meet the unique requirements of your space.*

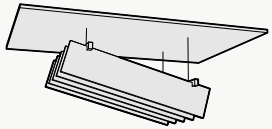
Rail Suspension Advantages

Rail suspension installation methods are designed for fast and easy installation by reducing the amount of suspension points. The rail structure acts as a guide for the baffles, maintaining baffle spacing and orientation while remaining easily customizable to fit most RCP layouts.

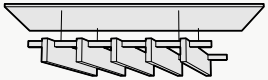
Pre-Defined Spacing



Consistent Angle



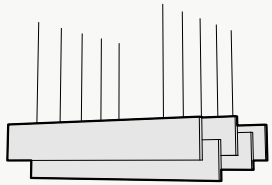
Non-Perpendicular Arrangements



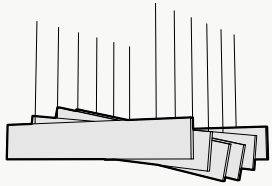
Individual Suspension Advantages

Individual suspension installation methods excel at accommodating irregular layouts. They are the most versatile installation style, and can be customized to fit even the most unique RCP layout.

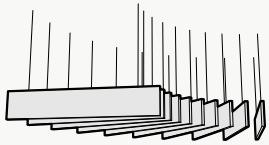
Height Variation



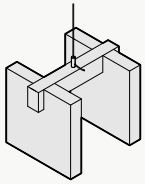
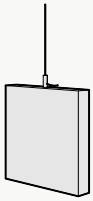
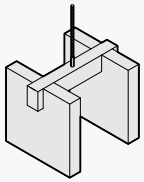
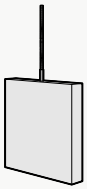
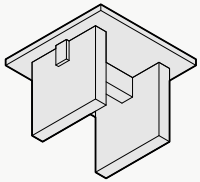
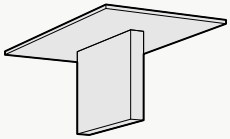
Angle Variation



Non-Linear Arrangements



Attachment Methods*

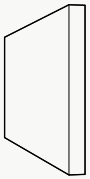
	Rail Suspension	Individual Suspension
Aircraft Cable + Fastest/easiest height adjustment + Largest height adjustment range + Height and angle versatility + Accommodates uneven ceiling surfaces and MEP		
Threaded Rod + Reduced product sway + Height and angle versatility + Accommodates uneven ceiling surfaces and MEP		
Mechanical Direct + Lowest profile installation method + Eliminates product sway + Connects to: Unistrut, ACT Grid, flat ceiling surfaces + Connections: Magnets, Grid Clips, Panel Clips, Metal Bracket, Custom		

*Not all listed attachment methods may be applicable to this product.

Material Layers

Soundcore®

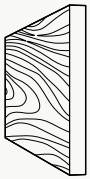
Our recycled PET felt creates an acoustic barrier, defending against wandering white noise and irritating echoes.



Single Layer
½" Thickness

Soundcore® Wood Textures

Soundcore® wood textures provide the natural aesthetic of wood while maintaining all the acoustic benefits of PET felt. Custom texture opportunities are also available upon request.



Single Layer
½" Thickness

Soundcore® | 1/2” Thickness

SND019
Linen

SND037
Paper

SND134
Oat

SND135
Vanilla Bean

SND105
Sand Dollar

SND109
Macadamia

SND111
Lanai

SND130
Buckskin

SND131
Abalone

SND125
Chinchilla

SND126
Wolfhound

SND118
Anchor

SND110
Starry Night

SND102
Morning Fog

SND114
Lunar Dust

SND034
Granite Peak

SND132
Cast Iron

SND103
Storm Cloud

SND038
Inkwell

SND122
Briquette

SND127
Burnt Toast

SND108
Ablaze

SND104
Pumpkin

SND141
Terracotta

SND106
Goldfinch

SND107
Grasshopper

SND113
Gruner

SND143
Olive

SND138
Fern

SND136
Clover

SND129
Dried Thyme

SND137
Cove

SND112
Tulum

SND139
Tidal

SND121
Apatite

SND123
Chrysocolla

SND117
Serene

SND124
Ice Floe

SND115
Mako

SND128
Arctic Ocean

SND133
Galactic

SND140
Marine

SND101
Commodore

SND042
Denim

SND142
Fig

Soundcore® Wood Textures | 1/2” Thickness

SND716
Dark Teak

SND792
Dark Oak

SND715
Dark Cherry

SND793
Vintage Maple

SND794
Warm Teak

SND714
English Walnut

SND795
Light Teak

SND711
Bleached Cherry

SND713
Honey Walnut

SND796
Vintage Cherry

SND717
Warm Oak

SND790
Natural Teak

SND712
Natural Spruce

SND709
White Maple

SND791
Gray Oak

SND710
Gray Teak

FIXTURE TYPE _____

PROJECT NAME _____

LOCATION _____

Easy 502 Uniform Static White (Indoor)

EASY-SPEC™: COMPONENTS TO EASILY SPECIFY A FIXTURE

RoHS COMPLIANT · CLASS 2 · TITLE 24 · PROP 65 · Field Cuttable · Dry Rated

Description

The Easy Spec series is designed for convenience and versatility, allowing you to quickly specify our standard Tape and Channel pairs with just one part number. Products arrive as individual components, providing your installation team the advantage of customizing lengths and configurations on-site for an optimal fit. Assembly services are available upon request.

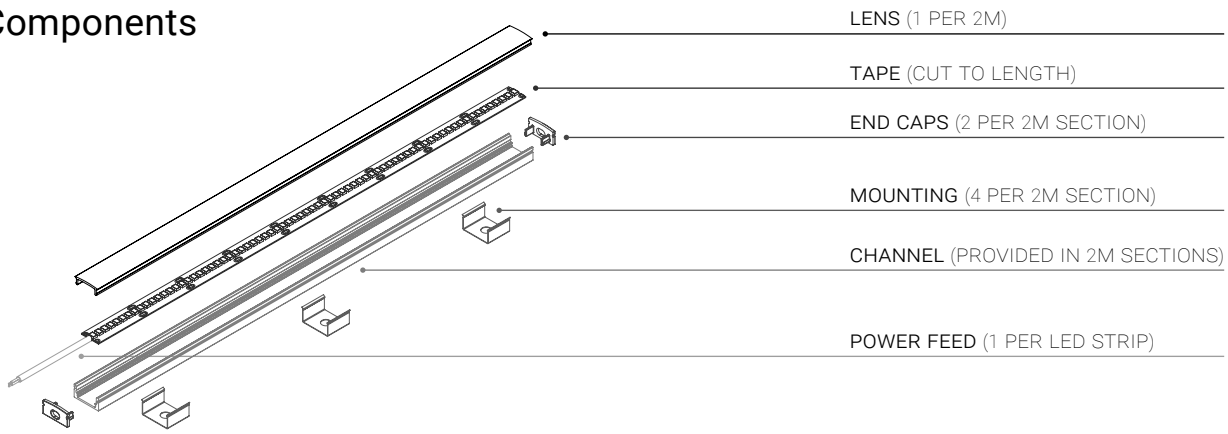
Features

- Field Serviceable Light Source & Engine
- Dimmable to 0.1%†
- Beam Angles As Narrow As 22.5°
- 5/10 Year Warranty for LED Strip / Drivers
- Optional Assembly Available For Any Fixtures Up to 8ft*
- Diode Imaging Free

Specifications

Series	Easy-Spec™
Tape/Fixture Type	Uniform Static White
Temp/Color*	1800K–6500K
Input Voltage	24V DC
Lumens per Foot*	44–1491
Watts per Foot*	0.7–14.4
Beam Spread	103.8°, 94.6°, 115.2°, 22.5°, 72.1°
CRI*	90+, 95+
Diodes*	U2835
Binning Tolerance*	3+ SDCM, 2 SDCM, 1 SDCM
Max Run Length	7–46ft
Width	0.67" (17.1mm)
Height§	0.31" (8.0mm)
Operating Temp	-4°F (-20°C) to 140°F (60°C)
Storage Temp	-4°F (-20°C) to 158°F (70°C)

Components



* Consult Factory for Additional Details

† When using ULV96-SC-DIM

§ When Paired With Standard Clips & Flat

For use with UL Light Source

Product Code Builder

Series	Channel	Indoor/ Outdoor	Tape Series	Temp/ Color	Lumen Output	Lens	Mounting	Finish
EZ	502	I						

Series

EZ — Easy-Spec™

Channel

502 — CH-502

Indoor/Outdoor

I — Indoor

Tape Series

- **U1** — Uniform Static White (1-Step)
- **U2** — Uniform Static White (2-Step)
- **U3** — Uniform Static White (3-Step)

Temp/Color

- **18K** — 1800K
- **22K** — 2200K
- **24K** — 2400K
- **27K** — 2700K
- **30K** — 3000K
- **35K** — 3500K
- **40K** — 4000K
- **50K** — 5000K
- **60K** — 6000K
- **65K** — 6500K

Lumen Output

- **100** — 100 lm/ft
- **200** — 200 lm/ft
- **300** — 300 lm/ft
- **400** — 400 lm/ft
- **500** — 500 lm/ft
- **750** — 750 lm/ft
- **1000** — 1000 lm/ft
- **1250** — 1250 lm/ft
- **1500** — 1500 lm/ft

Lens

- **C** — Clear
- **F** — Frosted
- **W** — White
- **CG** — Clear Graze
- **FG** — Frosted Graze

Mounting

- **P** — Plastic Clip
- **M** — Metal Clip
- **PV** — Pivot Clip

Finish

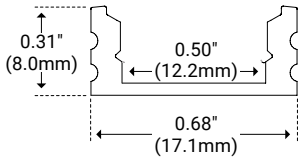
- **A** — Anodized Aluminum
- **W** — White Finish (WH-08)
- **B** — Black Finish (BK-08)
- **C** — Custom (RAL#)

Example: EZ-502-I-U1-18K-100-C-P-A

Channel

CH-502

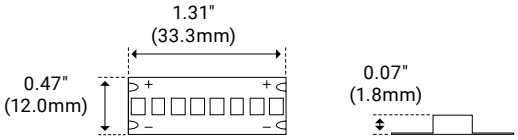
Unit Number	CH-502-2M
Width	0.68" (17.1mm)
Internal Width	0.50" (12.2mm)
Height	0.31" (8.0mm)



Tape Series

Uniform Static White (Indoor)

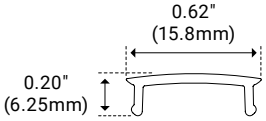
Unit Number	UNIx-WL-I-x-xK-24-NA
Diode	2835
Cut Intervals	1.31" (33.3mm)
Width	0.47" (12.0mm)
Height	0.07" (1.8mm)

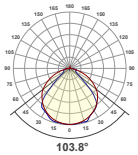


Lens

Clear

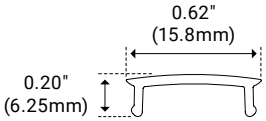
Unit Number	CH-LNS-A-CL-2M
Material	Polycarbonate
Transmission %	99%
Width	0.62" (15.8mm)
Height	0.20" (6.2mm)
Height w/product	0.34" (8.7mm)
Beam Angle	103.8°

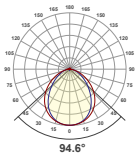




Frosted

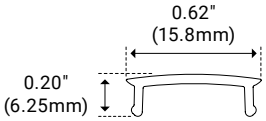
Unit Number	CH-LNS-A-FR-2M
Material	Polycarbonate
Transmission %	99%
Width	0.62" (15.8mm)
Height	0.20" (6.2mm)
Height w/product	0.34" (8.7mm)
Beam Angle	94.6°

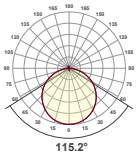




White

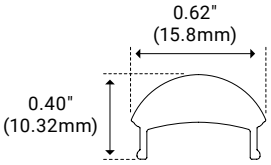
Unit Number	CH-LNS-A-WH-2M
Material	Polycarbonate
Transmission %	53%
Width	0.62" (15.8mm)
Height	0.20" (6.2mm)
Height w/product	0.34" (8.7mm)
Beam Angle	115.2°

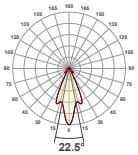




Clear Graze

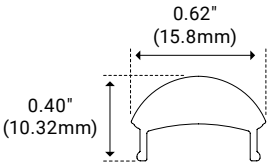
Unit Number	CH-LNS-G-CL-2M
Material	Polycarbonate
Transmission %	88%
Width	0.62" (15.8mm)
Height	0.40" (10.3mm)
Height w/product	0.52" (13.3mm)
Beam Angle	22.5°

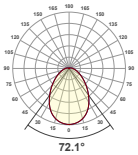




Frosted Graze

Unit Number	CH-LNS-G-FR-2M
Material	Polycarbonate
Transmission %	76%
Width	0.62" (15.8mm)
Height	0.40" (10.3mm)
Height w/product	0.52" (13.3mm)
Beam Angle	72.1°

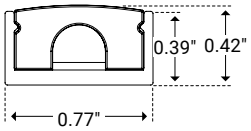




Mounting

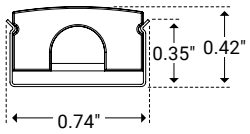
Plastic Clip

Unit Number	CH-502-PAK-P
Length	0.56" (14.3mm)
Width	0.77" (19.6mm)
Height	0.39" (9.8mm)
Height w/product	0.42" (10.6mm)



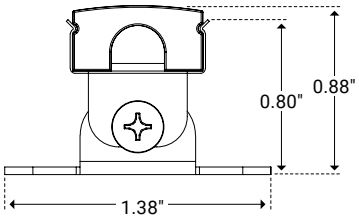
Metal Clip

Unit Number	CH-502-PAK-M
Length	0.59" (15.0mm)
Width	0.74" (18.8mm)
Height	0.35" (9.0mm)
Height w/product	0.42" (10.7mm)



Pivot Clip

Unit Number	CH-502-PAK-PV
Length	0.88" (22.5mm)
Width	1.38" (35.0mm)
Height	0.80" (20.4mm)
Height w/product	0.88" (22.3mm)



Finish

Anodized Aluminum

Unit Number	A
RAL	Silver Anodized

White*

Unit Number	W
RAL	WH-08

Black*

Unit Number	B
RAL	BK-08

Custom*

Unit Number	C
RAL	Custom

* Consult factory for pricing

Compatible Power Supplies

ULV36

Unit Number	ULV36	Voltage	24V DC
Length	4.50" (114.3mm)	Compatible Protocols	ELV, MLV, 0–10V, Resistive, PWM
Width	2.31" (58.6mm)	Dim Capability	5%
Height	1.37" (34.7mm)	Wattage	36W

Mini ULV96

Unit Number	ULV96-M	Voltage	24V DC
Length	10.75" (273.0mm)	Compatible Protocols	ELV, MLV, 0–10V, Triac
Width	3.00" (75.8mm)	Dim Capability	0.1%
Height	1.57" (40.0mm)	Wattage	96W

ULV192

Unit Number	ULV192	Voltage	24V DC
Length	11.37" (288.7mm)	Compatible Protocols	ELV, MLV, 0–10V, Resistive, PWM
Width	3.37" (85.5mm)	Dim Capability	1%
Height	1.37" (34.7mm)	Wattage	2x 96W

ULV96-SC-DIM

Unit Number	ULV96-SC-DIM	Voltage	24V DC
Length	14.96" (380.0mm)	Compatible Protocols	MLV, 0–10V
Width	3.03" (77.0mm)	Dim Capability	0.1%
Height	2.24" (57.0mm)	Wattage	96W

36P-24V

Unit Number	36P-24V	Voltage	24V DC
Length	3.50" (88.9mm)	Compatible Protocols	Resistive
Width	1.50" (38.1mm)	Dim Capability	10%
Height	1.12" (28.4mm)	Wattage	36W

60P-24V

Unit Number	60P-24V	Voltage	24V DC
Length	4.25" (107.9mm)	Compatible Protocols	Resistive
Width	1.75" (44.4mm)	Dim Capability	10%
Height	1.25" (31.75mm)	Wattage	60W

96P-24V

Unit Number	96P-24V	Voltage	24V DC
Length	4.25" (107.9mm)	Compatible Protocols	Resistive
Width	1.75" (44.4mm)	Dim Capability	10%
Height	1.25" (31.75mm)	Wattage	96W

Power Feeds (Factory Soldered)

Lead

Unit Number	FML-2C-6
AWG	20
Cable Length	6'
Connector Length	N/A
Connector Diameter	N/A

TM30 Data (1250lm/ft)

		CRI	Rf	Rg	R9
1-Step & 2-Step	1800K	95.7	93.5	100.2	73
	2200K	95	94.1	104.2	91
	2400K	95.7	94.3	104.4	91
	2700K	95.9	95.1	103.9	98
	3000K	97.2	95.3	102.7	98
	3500K	96.7	94.9	103.5	98
	4000K	97.3	94.9	102.5	97
	5000K	96.4	95.1	103.8	97
	6500K	96.9	94.2	102.5	97

		CRI	Rf	Rg	R9
3-Step	1800K	93.2	91.9	99.2	64
	2200K	93.6	91.2	105.2	79
	2400K	94.1	89.7	106.1	72
	2700K	94.1	92.3	105.5	94
	3000K	94.6	92.5	103.8	86
	3500K	96.7	92	100.2	80
	4000K	97.5	92	100	91
	5000K	89.7	90	103.3	49
	6500K	89	87.4	101	46

Delivered Lumens (1-Step/2-Step)

	Color/Temp Ordering Code	Lens	Output (lm/ft)								
			100	200	300	400	500	750	1000	1250	1500
1800K (90+CRI)	U1/U2-18K	White‡	41	92	144	189	217	325	412	530	624
2200K (90+CRI)	U1/U2-22K		49	112	174	229	262	383	486	624	735
2400K (90+CRI)	U1/U2-24K		51	116	180	237	272	405	514	660	778
2700K (90+CRI)*	U1/U2-27K		53	120	186	245	281	427	542	697	821
3000K (90+CRI)*	U1/U2-30K		57	130	202	267	305	445	565	726	855
3500K (90+CRI)*	U1/U2-35K		68	155	241	317	363	485	616	791	932
4000K (90+CRI)*	U1/U2-40K		61	138	215	283	324	480	610	784	923
5000K (90+CRI)*	U1/U2-50K		61	139	217	285	327	489	621	798	940
6500K (90+CRI)	U1/U2-65K		62	140	219	288	330	494	627	806	949
1800K (90+CRI)	U1/U2-18K	Frosted	76	172	268	354	405	607	770	990	1166
2200K (90+CRI)	U1/U2-22K		92	209	325	429	490	715	907	1166	1373
2400K (90+CRI)	U1/U2-24K		95	216	337	444	507	756	960	1234	1453
2700K (90+CRI)*	U1/U2-27K		98	223	348	458	525	798	1013	1302	1533
3000K (90+CRI)*	U1/U2-30K		107	243	378	498	570	831	1055	1356	1597
3500K (90+CRI)*	U1/U2-35K		127	289	450	593	678	906	1150	1478	1741
4000K (90+CRI)*	U1/U2-40K		113	258	401	528	604	897	1140	1464	1725
5000K (90+CRI)*	U1/U2-50K		114	260	405	533	610	914	1161	1491	1757
6500K (90+CRI)	U1/U2-65K		115	262	408	538	616	922	1171	1505	1773
1800K (90+CRI)	U1/U2-18K	Clear	76	172	268	354	405	607	770	990	1166
2200K (90+CRI)	U1/U2-22K		92	209	325	429	490	715	907	1166	1373
2400K (90+CRI)	U1/U2-24K		95	216	337	444	507	756	960	1234	1453
2700K (90+CRI)*	U1/U2-27K		98	223	348	458	525	798	1013	1302	1533
3000K (90+CRI)*	U1/U2-30K		107	243	378	498	570	831	1055	1356	1597
3500K (90+CRI)*	U1/U2-35K		127	289	450	593	678	906	1150	1478	1741
4000K (90+CRI)*	U1/U2-40K		113	258	401	528	604	897	1140	1464	1725
5000K (90+CRI)*	U1/U2-50K		114	260	405	533	610	914	1161	1491	1757
6500K (90+CRI)	U1/U2-65K		115	262	408	538	616	922	1171	1505	1773

* Customizable—Consult Factory

Delivered Lumens (1-Step/2-Step)

	Color/Temp Ordering Code	Lens	Output (lm/ft)								
			100	200	300	400	500	750	1000	1250	1500
1800K (90+CRI)	U1/U2-18K	Clear Graze	68	128	212	287	361	480	618	779	867
2200K (90+CRI)	U1/U2-22K		81	153	254	343	431	574	739	931	1036
2400K (90+CRI)	U1/U2-24K		84	158	263	355	446	594	765	963	1072
2700K (90+CRI)*	U1/U2-27K		87	166	274	371	466	620	799	1006	1120
3000K (90+CRI)*	U1/U2-30K		94	178	295	399	501	667	859	1082	1205
3500K (90+CRI)*	U1/U2-35K		112	212	351	475	596	794	1022	1288	1433
4000K (90+CRI)*	U1/U2-40K		99	187	310	419	526	700	902	1136	1265
5000K (90+CRI)*	U1/U2-50K		100	189	313	423	531	707	911	1147	1277
6500K (90+CRI)	U1/U2-65K		101	190	316	427	536	714	919	1158	1289
1800K (90+CRI)	U1/U2-18K	Frosted Graze	58	112	186	253	313	420	497	674	753
2200K (90+CRI)	U1/U2-22K		70	134	223	303	374	502	593	805	899
2400K (90+CRI)	U1/U2-24K		72	139	231	313	387	520	614	833	930
2700K (90+CRI)*	U1/U2-27K		75	145	241	327	405	543	642	870	972
3000K (90+CRI)*	U1/U2-30K		81	156	259	352	435	584	690	936	1046
3500K (90+CRI)*	U1/U2-35K		96	186	308	419	518	695	821	1113	1244
4000K (90+CRI)*	U1/U2-40K		85	164	272	370	457	613	725	982	1098
5000K (90+CRI)*	U1/U2-50K		86	165	275	373	461	619	731	992	1108
6500K (90+CRI)	U1/U2-65K		87	167	277	377	465	625	738	1001	1119

	Lens	Output (lm/ft)								
		100	200	300	400	500	750	1000	1250	1500
Efficacy (lm/W)	White	72	76	83	74	77	70	66	62	60
	Frosted	135	142	154	138	144	131	124	117	111
	Clear	135	142	154	138	144	131	124	117	111
	Clear Graze	118	105	118	102	125.25	104.21	101	93.27	83.68
	Frosted Graze	101	92	104	98	109	91	82	81	73
Wattage (W/ft)	All	0.8	1.7	2.5	3.6	4.0	6.4	8.5	11.6	14.4
Max Run Length (ft)	All	46	36	29	24	20	16	12	9	7

* Customizable—Consult Factory

Delivered Lumens (3-Step)

	Color/Temp Ordering Code	Lens	Output (lm/ft)								
			100	200	300	400	500	750	1000	1250	1500
1800K (90+CRI)	U3-18K	White‡	44	86	130	172	207	337	448	551	668
2200K (90+CRI)	U3-22K		48	94	142	187	225	355	474	582	705
2400K (90+CRI)	U3-24K		49	96	146	193	233	363	484	595	721
2700K (90+CRI)*	U3-27K		51	100	152	201	242	373	498	612	741
3000K (90+CRI)*	U3-30K		53	103	156	207	249	382	509	625	758
3500K (90+CRI)*	U3-35K		55	107	161	213	257	392	523	642	778
4000K (90+CRI)*	U3-40K		56	109	164	217	261	398	531	652	791
5000K (90+CRI)*	U3-50K		56	110	166	219	264	403	537	660	800
6500K (90+CRI)	U3-65K		58	114	172	228	275	402	536	659	798
1800K (90+CRI)	U3-18K	Frosted	82	160	243	321	387	629	838	1030	1248
2200K (90+CRI)	U3-22K		90	175	264	349	421	663	885	1087	1318
2400K (90+CRI)	U3-24K		92	180	273	361	435	678	905	1112	1347
2700K (90+CRI)*	U3-27K		96	187	284	375	452	697	930	1142	1385
3000K (90+CRI)*	U3-30K		99	193	292	386	465	713	950	1168	1416
3500K (90+CRI)*	U3-35K		102	199	301	398	480	732	976	1199	1453
4000K (90+CRI)*	U3-40K		104	203	306	405	488	743	991	1219	1477
5000K (90+CRI)*	U3-50K		105	205	310	410	494	752	1003	1233	1494
6500K (90+CRI)	U3-65K		109	213	322	426	514	750	1001	1231	1491
1800K (90+CRI)	U3-18K	Clear	82	160	243	321	387	629	838	1030	1248
2200K (90+CRI)	U3-22K		90	175	264	349	421	663	885	1087	1318
2400K (90+CRI)	U3-24K		92	180	273	361	435	678	905	1112	1347
2700K (90+CRI)*	U3-27K		96	187	284	375	452	697	930	1142	1385
3000K (90+CRI)*	U3-30K		99	193	292	386	465	713	950	1168	1416
3500K (90+CRI)*	U3-35K		102	199	301	398	480	732	976	1199	1453
4000K (90+CRI)*	U3-40K		104	203	306	405	488	743	991	1219	1477
5000K (90+CRI)*	U3-50K		105	205	310	410	494	752	1003	1233	1494
6500K (90+CRI)	U3-65K		109	213	322	426	514	750	1001	1231	1491

* Customizable—Consult Factory

Delivered Lumens (3-Step)

	Color/Temp Ordering Code	Lens	Output (lm/ft)								
			100	200	300	400	500	750	1000	1250	1500
1800K (90+CRI)	U1/U2-18K	Clear Graze	63	118	197	266	335	446	602	724	805
2200K (90+CRI)	U1/U2-22K		75	141	236	318	401	533	719	865	961
2400K (90+CRI)	U1/U2-24K		78	146	244	329	415	551	744	895	995
2700K (90+CRI)*	U1/U2-27K		82	153	255	344	433	576	777	935	1040
3000K (90+CRI)*	U1/U2-30K		88	164	274	370	466	619	825	1006	1118
3500K (90+CRI)*	U1/U2-35K		104	196	326	440	554	737	995	1197	1330
4000K (90+CRI)*	U1/U2-40K		92	173	288	388	489	650	878	1056	1174
5000K (90+CRI)*	U1/U2-50K		93	174	290	392	494	656	886	1066	1185
6500K (90+CRI)	U1/U2-65K		94	176	293	396	498	663	894	1076	1196
1800K (90+CRI)	U1/U2-18K	Frosted Graze	53	102	171	232	287	384	522	616	689
2200K (90+CRI)	U1/U2-22K		63	122	204	277	342	459	624	736	823
2400K (90+CRI)	U1/U2-24K		65	127	211	287	354	475	645	761	852
2700K (90+CRI)*	U1/U2-27K		68	132	220	300	370	496	674	796	890
3000K (90+CRI)*	U1/U2-30K		73	142	237	322	398	533	713	856	957
3500K (90+CRI)*	U1/U2-35K		87	169	282	384	474	635	863	1018	1139
4000K (90+CRI)*	U1/U2-40K		77	149	249	338	418	560	761	898	1005
5000K (90+CRI)*	U1/U2-50K		78	151	251	342	422	565	769	907	1015
6500K (90+CRI)	U1/U2-65K		79	152	254	345	426	571	776	915	1025

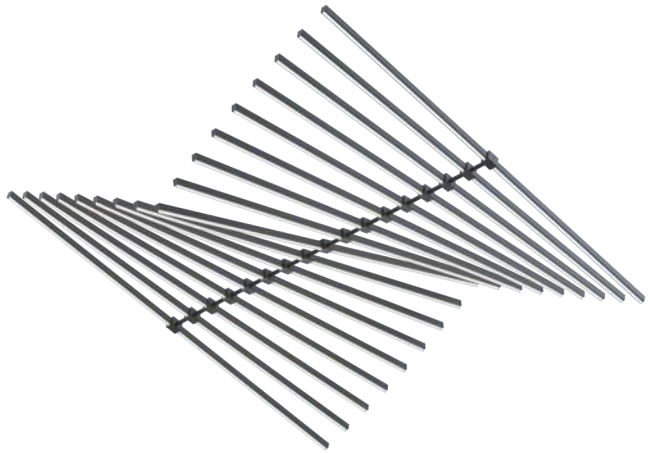
	Lens	Output (lm/ft)								
		100	200	300	400	500	750	1000	1250	1500
Efficacy (lm/W)	White	76	80	78	80	73	87	91	87	88
	Frosted	141	149	146	149	137	162	170	162	165
	Clear	141	149	146	149	137	162	170	162	165
	Clear Graze	126	126	137	142	137	141	147	140	130
	Frosted Graze	104	109	119	124	117	121	127	119	111
Wattage (W/ft)	All	0.7	1.3	2.0	2.6	3.4	4.4	5.6	7.2	8.6
Max Run Length (ft)	All	46	30	25	22	19	17	14	11	11

* Customizable—Consult Factory

Coronet®
designed and built in the USA

a CarbonNeutral company

Wave direct

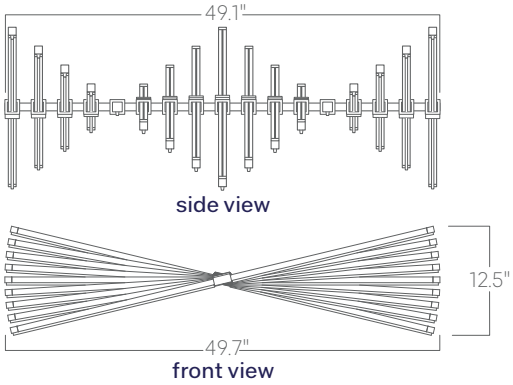


Our Performance Decorative luminaires offer a variety of decorative forms and sizes, suitable for any modern space.

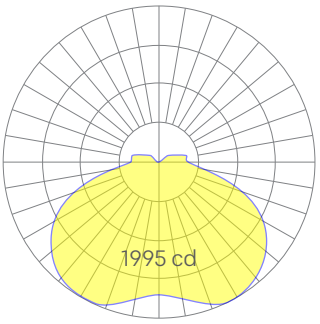
Features

- Extruded recycled aluminum housing
- Specifiable color temperature. CRI > 90, R9 > 50
- Specifiable dimmable drivers or PoE
- Custom colors and wood finishes available
- 5 Year, 50,000 hour warranty, damp location rated
- WELL Building Standard compatible learn more

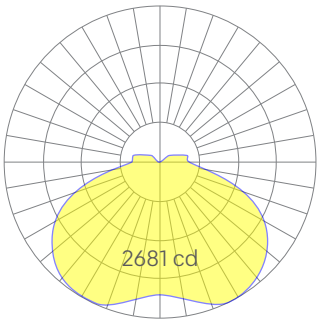
Dimensions



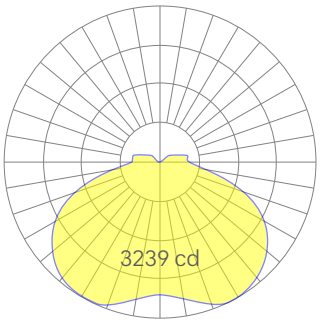
Optics



low



medium



high

Representative distribution and peak candela. For other options see order information or IES files here.

Modification date: August,2025

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Coronet reserves the right to make design changes.

Ordering Information

For each option group below specify one option. If you don't see your preferred option listed, contact us for help.

1	Fixture ID	2	Length	3	Color Temperature	4	Output
WAVE		4	4 ft	30	3000K/90 CRI	LOW	Low output
				35	3500K/90 CRI	MED	Medium output
						HIGH	High output
						CUST	Custom output Specify watts or lumens

5	Voltage	6	Driver	7	Finish	8	Mounting
UNV	Universal (120/277V)	DB	Standard 0-10V 1%	W	White	PS.X	Pendant stem (12", 18", 24", 36", 48") White canopies and power cord unless option specified in section 12.
347V	347V Must use DB Driver	PoE	Power over Ethernet.	BLK	Black	PSFC	Field Cuttable Pendant Stem 94" Stem, field cuttable to any length. White stems, canopies and power cord unless option specified in section 12.
			Linear Dimming Curve by default. Consult factory for Logarithmic options.	SLV	Silver		
				CC	Custom Color See finish options here.		

9	Optics	10	Sensors/Controls	11	Circuit	12	Options
SD	Standard Diffuser	NA	None	NA	None	NA	None
		ACM	Acuity nLight Module Only	EMCKT	Emergency circuit		
		CCS	Casambi Module	DAYCKT	Daylight circuit May require additional power feeds.		
		AWNR	Lutron Athena Wireless Node Module				
		OTHER	Consult Factory				

Performance

Output[1]	Watts	Lumens
Low	160	8040
Medium	215	10804
High	261	13116

[1]Based on a typically configured 90 CRI, 3500K luminaire using one driver.
Custom outputs available. Please consult factory.
For 4000K multiply by 1.05; for 3000K, 0.96; for 2700K, 0.92.

Technical Information

click here or scan QR code

Wiring diagrams, PoE and sensor details

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Suitable for Damp Locations
UNION MADE IN THE USA
Intertek

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Wave direct

Drivers & Electrical
Remote, dimmable drivers are supplied in enclosures.
For remote driver box sizes, click here.

Emergency Back-Up
Emergency, battery-powered drivers are available. Emergency circuits for use with building generators are aslo available.

PoE (Power over Ethernet)
Compatible with virtually all PoE systems including Molex Coresync, Igor, Smartengine, Platformatics, and NuLED SPICEbox.
Consult factory for systems not listed. See here for more info.

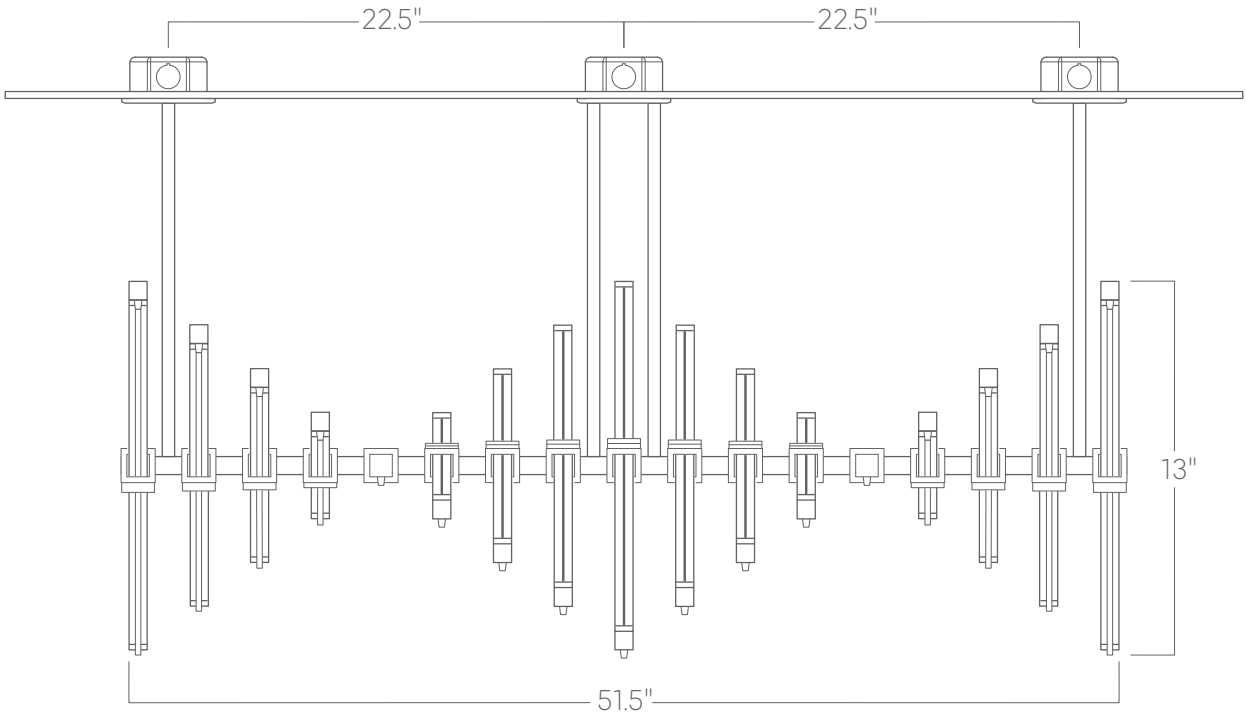
Weight
40 lbs

Optics
Extruded satin acrylic TIR optic provides excellent diffusion, high transmission, and no LED imaging.

Construction
Extruded, recycled aluminum housing.

Finishes
All luminaires are finished in high quality polyester powder coating. Our standard color is white. Any RAL color may be specified.

Mounting Options



Pendant stem

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12V Concealed LED Aisle Light
Fact Sheet

Concealed LED Aisle Light is recessed in the underside of designated aisle standard armrests or within the recess of the No. 10 aisle panel, providing illumination on the aisle panel and floor/step adjacent to the standard. The light fixture is powered with 12 volt, D.C., power from a centralized source (class II power supply required). Aisle light equipped standards are pre-wired at the factory.

Aisle lights are provided as a decorative accessory designed to illuminate the edge of the aisle passageway. Aisle lights are not designed to provide consistent illumination across the entire aisle. Irwin Seating recommends that a lighting expert be consulted to insure compliance with all safety codes.

Detailed Technical Description:

1. Light fixture is approximately 6” x 1/2”, containing six warm white LED elements.
2. Aisle light equipped standards are pre-wired at the factory with two 18 gauge wire leads, contained in flexible conduit. Standards for the No. 8 and No. 17 chair platforms use a 3/8” connector and extend the two 18 gauge wires approximately 18 inches beyond the connector. Pre-wired standards for the No. 4 chair platform extend a black, split-loom conduit approximately 18” beyond the point it exits from the aisle panel.
3. Power Supply and House Wiring Specifications:
   Primary Voltage: 120 volts, AC, 60 hz (15 amp)
   Secondary Voltage: 12 volts, DC
   Secondary Wiring: Consult Electrical Contractor (see chart below).
4. Class II Power Driver purchased from Irwin Seating is UL and ETL listed, designed to provide 12 volt, DC, lighting power, and may be supplied for each group of aisle lights having a common power supply. Transformer/rectifier is designed for 60 watt output (allows service for up to 100 aisle lights). Complex aisle lighting systems with multiple aisles and power sources may require design by a qualified Electrical Engineer.
5. Power Requirements: 0.48 watt per aisle standard (0.0400 Amp) 12 volt, DC

Maximum Length Of Wire Run Allowed For Class II 12 Volt DC Driver

Chart shows values of maximum feet of wire run depending upon wire gauge and system electrical consumption.

	System Wattage				
Wire Gauge	20W	30W	40W	50W	60W
14 ga.	155’	103’	77’	62’	52’
12 ga.	247’	164’	123’	98’	82’
10 ga.	387’	260’	194’	155’	130’
8 ga.	623’	416’	310’	250’	207’

6% voltage drop and operating temperature of 65°C is used for these calculations. Solid copper wire is recommended when using this chart. These are only estimates. Please consult local electrical codes for requirements.

Method of Installation:

The seating manufacturer / certified installer shall install the pre-wired aisle standards associated with auditorium chairs. Seating contractor will also deliver to the electrical construction authority the Class II Power Driver, purchased from Irwin Seating Company as part of the seating contract. It is the responsibility of the Electrical Contractor (via a licensed Electrician) to make all wiring connections from the electrical distribution system to the aisle lights. Irwin Seating Company does not furnish anything beyond the 18” lead and all other wiring, conduit, junction boxes, etc. are the responsibility of the Electrical Construction Contractor. The Electrical Construction Contractor shall mount and install the power supply / driver.

12V Concealed LED Aisle Light
Illumination Pattern

No. 66 Aisle Standard
(No. 8 Chair Platform)

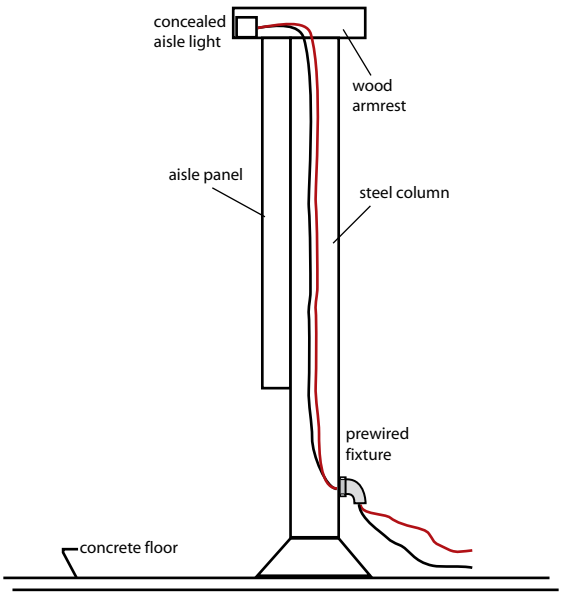
0.45	0.60	0.89	1.31	1.81	2.26	2.50	2.50	2.26	1.81	1.31	0.89	0.60	0.45	0.0″
0.37	0.56	0.79	1.10	1.45	1.77	1.92	1.92	1.77	1.45	1.10	0.79	0.56	0.37	3.0″
0.31	0.43	0.62	0.85	1.08	1.30	1.40	1.40	1.30	1.08	0.85	0.62	0.43	0.31	6.0″
0.25	0.33	0.47	0.61	0.77	0.91	0.96	0.96	0.91	0.77	0.61	0.47	0.33	0.25	9.0″
0.21	0.26	0.35	0.45	0.53	0.61	0.64	0.64	0.61	0.53	0.45	0.35	0.26	0.21	12.0″
0.17	0.22	0.27	0.34	0.39	0.42	0.44	0.44	0.42	0.39	0.34	0.27	0.22	0.17	15.0″
0.14	0.16	0.21	0.25	0.28	0.29	0.29	0.29	0.29	0.28	0.25	0.21	0.16	0.14	18.0″
0.11	0.14	0.15	0.18	0.20	0.20	0.20	0.20	0.20	0.20	0.18	0.15	0.14	0.11	21.0″
0.08	0.10	0.10	0.12	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.10	0.10	0.08	24.0″
														27.0″
21.0″	18.0″	15.0″	12.0″	9.0″	6.0″	3.0″	0.0″	3.0″	6.0″	9.0″	12.0″	15.0″	18.0″	21.0″

Average foot candle: 0.59
Total foot candle: 73.85

12 volt concealed LED aisle light mounted in underside of a wood armrest on a 66.8 aisle standard surfaced with Jett Black laminate. Aisle standard is “L” (level) standard, placing the center of the aisle light approximately 22” above the floor.

The pattern shown is typical, actual results may vary slightly.

Aisle lights are provided as a decorative accessory designed to illuminate the edge of the aisle passageway. Aisle lights are not designed to provide consistent illumination across the entire aisle. Irwin Seating recommends that a lighting expert be consulted to ensure compliance with all safety codes.



12V Concealed LED Aisle Light
Illumination Pattern

No 66 Aisle Standard
(No. 4 Chair Platform)

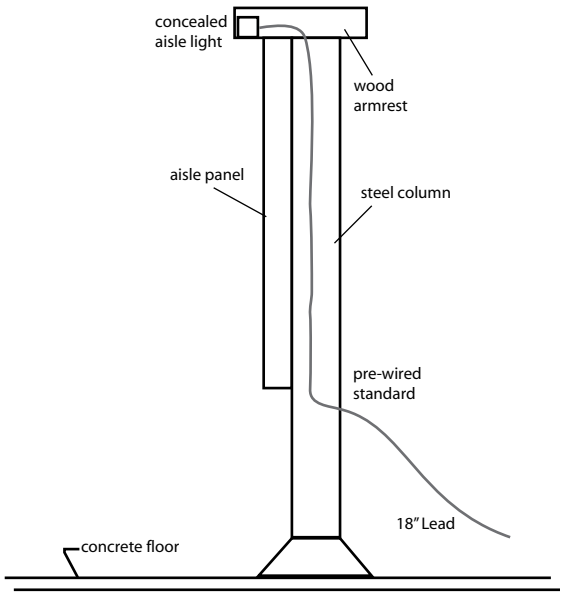
0.19	0.30	0.51	0.82	1.41	2.12	2.79	3.01	2.75	2.06	1.34	0.79	0.46	0.24	0.0″
0.21	0.33	0.54	0.85	1.35	1.99	2.51	2.71	2.47	2.01	1.45	0.94	0.61	0.40	3.0″
0.18	0.28	0.43	0.68	1.04	1.51	1.86	2.01	1.88	1.51	1.18	0.80	0.55	0.36	6.0″
0.14	0.23	0.35	0.51	0.75	1.04	1.28	1.41	1.37	1.08	0.87	0.61	0.44	0.31	9.0″
0.12	0.17	0.27	0.38	0.52	0.69	0.84	0.93	0.91	0.77	0.60	0.46	0.35	0.23	12.0″
0.09	0.14	0.19	0.27	0.37	0.48	0.55	0.59	0.57	0.50	0.42	0.33	0.25	0.18	15.0″
0.07	0.11	0.15	0.20	0.28	0.34	0.39	0.40	0.40	0.36	0.31	0.25	0.19	0.14	18.0″
0.05	0.08	0.11	0.15	0.20	0.23	0.26	0.27	0.27	0.26	0.23	0.18	0.14	0.10	21.0″
0.03	0.05	0.07	0.09	0.12	0.15	0.16	0.16	0.17	0.17	0.15	0.13	0.11	0.08	24.0″
														27.0″
21.0″	18.0″	15.0″	12.0″	9.0″	6.0″	3.0″	0.0″	3.0″	6.0″	9.0″	12.0″	15.0″	18.0″	21.0″

Average foot candle: 0.64
Total foot candle: 80.98

12 volt concealed LED aisle light mounted in underside of a wood armrest on a 66.4 aisle standard surfaced with Jett Black laminate. Aisle standard is “L” (level) standard, placing the center of the aisle light approximately 23” above the floor.

The pattern shown is typical, actual results may vary slightly.

Aisle lights are provided as a decorative accessory designed to illuminate the edge of the aisle passageway. Aisle lights are not designed to provide consistent illumination across the entire aisle. Irwin Seating recommends that a lighting expert be consulted to ensure compliance with all safety codes.



12V Concealed LED Aisle Light
Illumination Pattern

No. 10 Aisle Standard
(No. 4 Chair Platform)

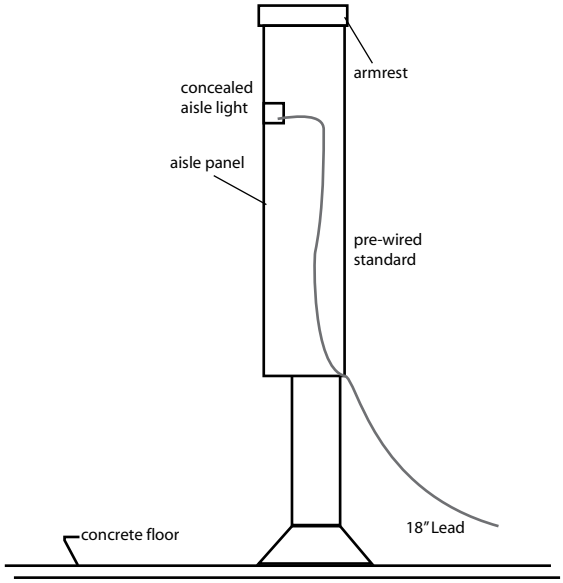
0.19	0.30	0.51	0.82	1.41	2.12	2.79	3.01	2.75	2.06	1.34	0.79	0.46	0.24	0.0″
0.21	0.33	0.54	0.85	1.35	1.99	2.51	2.71	2.47	2.01	1.45	0.94	0.61	0.40	3.0″
0.18	0.28	0.43	0.68	1.04	1.51	1.86	2.01	1.88	1.51	1.18	0.80	0.55	0.36	6.0″
0.14	0.23	0.35	0.51	0.75	1.04	1.28	1.41	1.37	1.08	0.87	0.61	0.44	0.31	9.0″
0.12	0.17	0.27	0.38	0.52	0.69	0.84	0.93	0.91	0.77	0.60	0.46	0.35	0.23	12.0″
0.09	0.14	0.19	0.27	0.37	0.48	0.55	0.59	0.57	0.50	0.42	0.33	0.25	0.18	15.0″
0.07	0.11	0.15	0.20	0.28	0.34	0.39	0.40	0.40	0.36	0.31	0.25	0.19	0.14	18.0″
0.05	0.08	0.11	0.15	0.20	0.23	0.26	0.27	0.27	0.26	0.23	0.18	0.14	0.10	21.0″
0.03	0.05	0.07	0.09	0.12	0.15	0.16	0.16	0.17	0.17	0.15	0.13	0.11	0.08	24.0″
														27.0″
21.0″	18.0″	15.0″	12.0″	9.0″	6.0″	3.0″	0.0″	3.0″	6.0″	9.0″	12.0″	15.0″	18.0″	21.0″

Average foot candle: 0.65
Total foot candle: 82.35

12 volt concealed LED aisle light mounted in underside of a wood armrest on No. 10 Aisle Standard surfaced with Jett Black laminate. Aisle standard is “L” (level) standard, placing the center of the aisle light approximately 20.75” above the floor.

The pattern shown is typical, actual results may vary slightly.

Aisle lights are provided as a decorative accessory designed to illuminate the edge of the aisle passageway. Aisle lights are not designed to provide consistent illumination across the entire aisle. Irwin Seating recommends that a lighting expert be consulted to ensure compliance with all safety codes.



JUNO

Project:

Fixture Type:

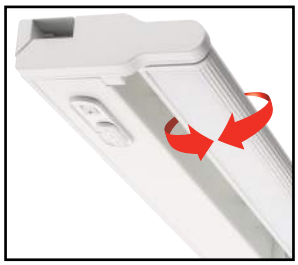
Location:

Contact/Phone:

UNDERCABINET LIGHTING

LED SWITCHABLE WHITE, DIMMABLE

UPLD



PRODUCT DESCRIPTION

Available in four lengths, the UPLD Swivel LED undercabinet includes an easily accessible switch to select 3000K, 3500K or 4000K color temperature with 50,000 hours of life. Provides task or accent lighting in commercial, retail, hospitality and residential applications. Ideal for use over and under cabinets, display cases, task lighting, office lighting, coves and utility/work areas.

Warranty 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

PRODUCT SPECIFICATIONS

LEDs Utilizes long-life, high-efficiency LEDs binned to within a 3-step MacAdam ellipse for excellent color consistency • Rated for 50,000 hours at 70% lumen maintenence • 90 CRI minimum • The UPLD uses an improved, recessed linking mechanism that allows two fixtures to connect together with virtually no gap between with included row connector.

Driver Integrated, high efficiency 120v, 60Hz driver • Dimmable • Works with most standard incandescent, magnetic low voltage or electronic low voltage dimmers • Compatible with most residential phase-cut dimmers.

Housing Slim 1" profile • Light bar has 20 degree swivel in each direction • Housing end caps can be pivoted for easy access to linking port • Linkable, plug-together design to connect fixture-to-fixture • Available in white or bronze finishes • Each fixture has an integrated ON/OFF switch for independent power control • Juno Pro-Series accessories are not compatible • For a complete list of compatible accessories, see below

Diffuser Lightly frosted, acrylic diffuser for maximum light transmission and uniform light distribution • Swivel head allows light to be directed to desired area.

Labels cULus listed to US and Canadian safety standards • Listed for Damp Locations • Can be used to comply with 2019 Title 24, Part 6, JA8 high efficacy LED light source requirements.

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

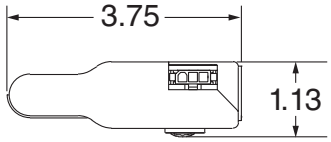
INSTALLATION

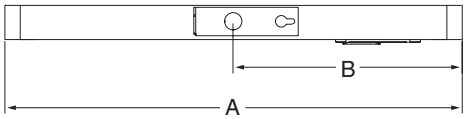
UPLD Series fixtures offer several convenient methods for installation and can be installed as direct wire or portable luminaires. Fixtures may be mounted flush to the backsplash or up against the front lip of the cabinetry using captive mounting screws.

Direct Wire The UPLD 9", 14", 22" and 30" lengths have a rear wiring access compartment and push-in electrical connectors for direct-wire application • Each length includes a die cast fitting for 3/8" flexible metal conduit • Optional UCD JB Junction/Splice box (sold separately) is available to facilitate bringing power to front end of cabinetry and then using jumper cords to connect to fixtures (see installation diagram below) • All standard mounting hardware included • 17" jumper wire and straight joiner (row) connector are included accessories.

Electrically Connecting Multiple Fixtures Fixtures can be electrically joined together using either the straight joiner (row) connector supplied with each fixture or with the included 17" connector jumper cord or optional 24" UC ERC24 connecting cord. No more than 29 units of any size should be linked together.

DIMENSIONS





	Dim A	Dim B
UPLD 09	9	3.56
UPLD 14	14	7
UPLD 22	22	11
UPLD 30	30	15

ENGINEERING DATA

	9"			14"			22"			30"		
	3000K	3500K	4000K	3000K	3500K	4000K	3000K	3500K	4000K	3000K	3500K	4000K
Lumens	291	307	301.59	471	506	498.63	826	886	867	1105	1187	1166
CCT	3044	3544	4036	3040	3525	4027	3047	3543	4032	3006	3526	4017
CRI	94	95	95.37	94	96	95	94	96	95	95	96	95
Wattage	4.5	4.39	4.47	6.79	6.54	6.65	11.41	11.07	11.33	15.3	14.9	15.2
Lumens/Watt	64.61	69.83	67.48	69.41	77.3	75.03	72.35	79.99	76.54	72.23	79.67	76.73
Amperage	0.04A	0.04A	0.04A	0.06A	0.06A	0.06A	0.10A	0.10A	0.10A	0.13A	0.13A	0.13A

ORDERING INFORMATION

Example: UPLD 09IN SWW4 90CRI WH

Series	Length	CCT	Minimum CRI	Finish
UPLD Swivel LED Undercabinet	**09IN** 9 inch **14IN** 14 inch **22IN** 22 inch **30IN** 30 inch	**SWW4** 3000K, 3500K, 4000K	**90CRI** 90 CRI	**BZ** Bronze **WH** White

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UNDERCABINET LIGHTING

LED SWITCHABLE WHITE, DIMMABLE

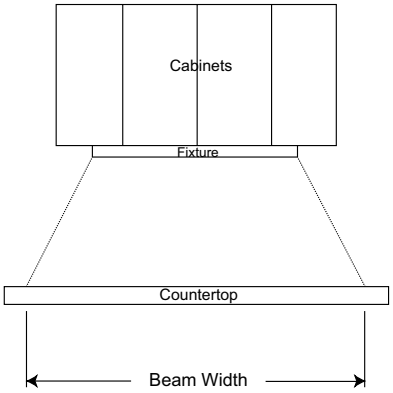
UPLD

Accessories: *Order as separate catalog number.*	
UC 5FT POWERCORD WH M6	White 5' cord and plug
UC 5FT POWERCORD BL M6	Black 5' cord and plug
UCD JB M12	White Junction/Splice box - allows for quick and easy direct wiring
UCD JB BL M12	Black Junction/Splice box - allows for quick and easy direct wiring
UC ERC24 R4 [1]	White 24" connector cord for longer length connections between fixtures or splice box (required for splice box to first fixture)
UC ERC24 BL M12	Black 24" connector cord for longer length connections between fixtures or splice box (required for splice box to first fixture)

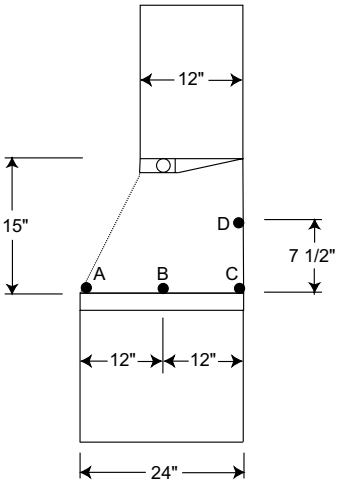
1. Ships as quantity 4 retail pack.

LIGHTING APPLICATION DATA

FOOTCANDLES ON HORIZONTAL WORK SURFACE



Front View



Side View

Catalog Numbers	Beam Width*	Footcandles*			
		A	B	C	D
UPLD 09IN	20	17.9	38.7	22	34.3
UPLD 14IN	23	29.2	53.3	33.4	47.6
UPLD 22IN	28	45.4	83.5	56.2	78.9
UPLD 30IN	33	54.1	110.5	64.3	90.5

* Beam width defined as 50% of maximum footcandles
Fixture mounted at front lip of cabinet
Rear wall reflectance 50%
Counter Surface Reflectance 20%

*Footcandles calculated with swivel bar facing straight down

DIMMER COMPATIBILITY

Lutron	Eaton
Skylark SCL-153P	HALO SAL06P
Toggler TGCL-153P	
Lumea LECL-153P	
Maestro MACL-153M	
Caseta PD-6WCL	
DVCL-153P	
D-603P	
CT-603P	
DVELV-300P	
DV-603P	
S-600P	

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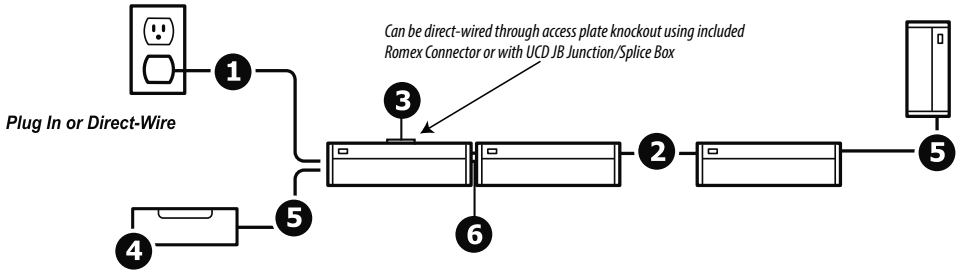
UNDERCABINET LIGHTING

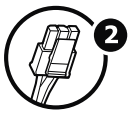
LED SWITCHABLE WHITE, DIMMABLE

UPLD

Installation



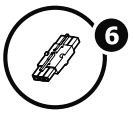
Included



2 — 17" Connector Cord

3 — Direct wire access

Captive Mounting Screws



6 — Straight joiner (row) connector included

Accessories

sold separately

Model # UC 5FT POWERCORD WH
UC 5FT POWERCORD BL

1 — Optional UC 5FT powercord

Model # UCD JB
UCD JB BL

4 — UCD JB Junction/Splice Box (optional)

Model # UC ERC24
UC ERC24 BL

5 — 17" (included) or 24" (optional) connecting cord

Switchable White and On/Off Switch

- Simply switch between 3000, 3500, or 4000K CCT
- Choose CCT to enhance space based on décor
- Simplifies Distributor's inventory and choice for customer

Simple to Install

- Captive screws eliminates frustration during installation
- Can be installed as direct wired or portable luminaires
- Fixtures can be electrically joined together using either the included straight joiner (row) connector or 17" connector jumper cord, or optional 24" UC ERC24 connecting cord.

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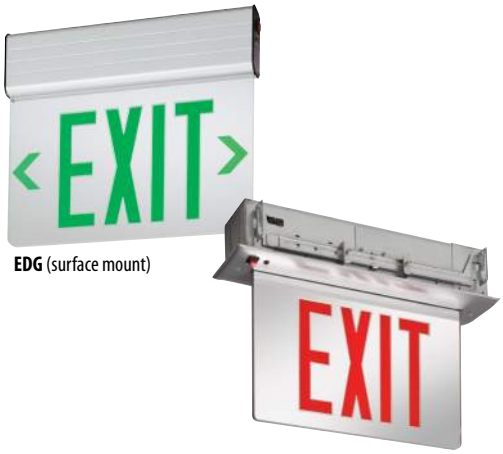
LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

QUANTUM®

LED Edge-Lit Exits

EDG
EDGR



EDG (surface mount)

EDGR (recessed mount)

FEATURES & SPECIFICATIONS

INTENDED USE — Suitable for applications requiring attractive edge-lit exit signage, universal installation and low energy consumption.

CONSTRUCTION — Extruded brushed aluminum finish.

Clear acrylic panels- letters measure 6" high with 3/4" stroke, with 100 ft viewing distance rating, based upon UL 924 standard.

For single-face clear panels, EXIT is seen as a reversed image from the back.

OPTICS — LEDs mounted on printed circuit board. The typical life of the exit LED lamp is 5 years, based on 24/7 operation.

The LED operating frequency is 120Hz.

ELECTRICAL — Dual voltage input capacity (120/277V).

Battery: (EL Option) – Sealed, maintenance free nickel-cadmium battery delivers 90 minutes capacity to emergency lamps. Test switch provides manual activation of 30-second diagnostic testing for on-demand visual inspection.

Self-diagnostic testing (EL Option Only) for 30 seconds every 30 days and 90 minutes annually. Diagnostic evaluation of LED light source, AC to DC transfer, charging and battery condition.

INSTALLATION — EDG – Universal mounting canopy for top or end mount. Back mount standard for single face only. Canopy provided.

EDGR – Recessed mounting. Bar hanger and brackets provided for both new or restricted ceiling access installation applications. Available for use in drop ceiling applications. Back wall mount (WM) option.

Universal directional indicators. Field selected and attached.

LISTINGS — UL damp location listed 32°-122°F (0°-50°C) standard. Meets UL924, NFPA 101 (current Life Safety Code), NEC and OSHA illumination standards. Meets all applicable FCC Title 47, Part 15, Subpart B requirements.

BUY AMERICAN ACT — BAA – Buy America(n) Act: Product with the BAA option qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product with the BAA option also qualifies as manufactured in the United States under DOT Buy America regulations.
Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty (Battery is prorated). This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at:
www.acuitybrands.com/support/warranty/terms-and-conditions

NOTE: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

† Exit Signs Certified in the CA Title 20 Appliance Efficiency Database.

Specifications

EDG (End Mount)	**EDG (Top Mount)**
Length: 13 (33.0)	Length: 13-5/8 (34.6)
Depth: 5-1/2(14.0)	Depth: 4-5/16 (11.0)
Height: 11-1/8 (28.3)	Height: 11-3/4 (29.8)
Shipping Weight : 4 lbs (1.8 kgs)	Shipping Weight: 4 lbs (1.8 kgs)
EDG (Back Mount)	**EDGR**
Length: 13 (33.0)	Length: 13 (33.0)
Depth: 3 (7.6)	Depth: 1-3/4 (4.4)
Height: 11-1/8 (28.3)	Height: 8 (20.3)
Shipping Weight: 4 lbs (1.8 kgs)	Shipping Weight: 6.8 lbs (3.1 kgs)
	Shipping Weight (WM option): 8.1 lbs (3.7 kgs)

All dimensions are inches (centimeters) unless otherwise noted.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.

*See ordering tree for details

Design Select options indicated by this color background.

ORDERING INFORMATION For shortest lead times, configure products using **bolded options**. **Example**: EDG 1 R EL

Family	Housing color	Number of faces	Letter color		Operations	Options
EDG Surface mount LED edge-lit exit	**(blank)** Brushed aluminum	**1** Single face	**R** Red on clear (single face only)[1]	RMR Red on mirror[2]	**(blank)** AC only	**(blank)** None
EDGR Recessed LED edge-lit exit	W White	**2** Double face	**G** Green on clear (single face only)[1]	GMR Green on mirror[2]	**EL** Nickel-cadmium battery	WM Recessed wall mount[7]
				RW Red on white[3]	X2 Lamp wired on two separate AC circuits (specify 120V or 277V)[4,5]	BAA Buy America(n) Act Compliant
				GW Green on white[3]	SD Self-diagnostics[6]	

Accessories: Order as separate item.	
ELA US12	12" stem kit with brushed aluminum canopy[8]
ELA W US12	12" stem kit with white canopy[8]
ELA WG1	Wireguard (13 3/4"H x 15 1/4"W x 6" D, back mount only)

Notes
1 For single-face clear panels, EXIT is seen as a reversed image from the back.
2 Available with single and double face.
3 White panel standard for double and single face.
4 Both circuits can be energized at the same time.
5 Not available with EL and SD options.
6 Available with EL option only.
7 Available on EDGR single face only
8 See spec sheet ELA-StemKits. Only available for EDG.

SPECIFICATIONS

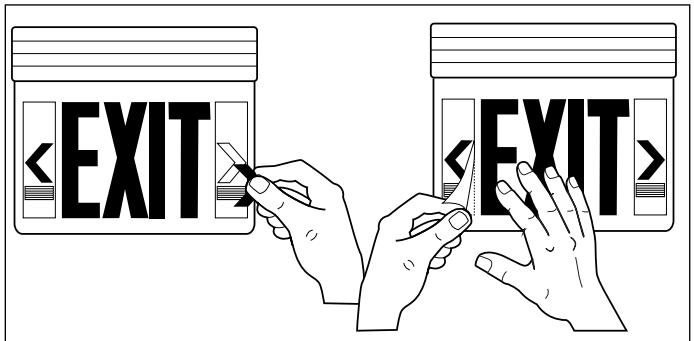
ELECTRICAL						
Primary Circuit						
Type	**Typical LED life[1]**	**Supply voltage**	**EDG**		**EDGR**	
			Input Watts	**Max amps.**	**Input Watts**	**Max amps.**
Red LED AC only	>5 years	120	2.5	0.020	3.8	0.030
		277	2.8	0.010	4.5	0.014
Green LED AC only	>5 years	120	2.2	0.020	3.8	0.030
		277	2.2	0.010	4.5	0.020
Red LED emergency	>5 years	120	3.0	0.030	3.8	0.031
		277	3.1	0.010	4.5	0.015
Green LED emergency	>5 years	120	2.6	0.020	3.8	0.031
		277	2.8	0.010	4.5	0.020

BATTERY (EL option)			
Sealed Nickel-Cadmium			
Shelf life[2]	Typical life[2]	Maintenance[3]	Temperature range[4]
3 years	6-8 years	none	32-122°F (0-50°C)

Notes

1. Based on 24/7 operation. The typical life of the exit LED lamp is 5 years.
2. At 77°F (25°C).
3. All life safety equipment, including emergency lighting for path of egress must be maintained, serviced, and tested in accordance with all National Fire Protection Association (NFPA) and local codes. Failure to perform the required maintenance, service, or testing could jeopardize the safety of occupants and will void all warranties.
4. Temperature range where unit will provide capacity for 90 minutes. Higher and lower temperatures affect life and capacity.

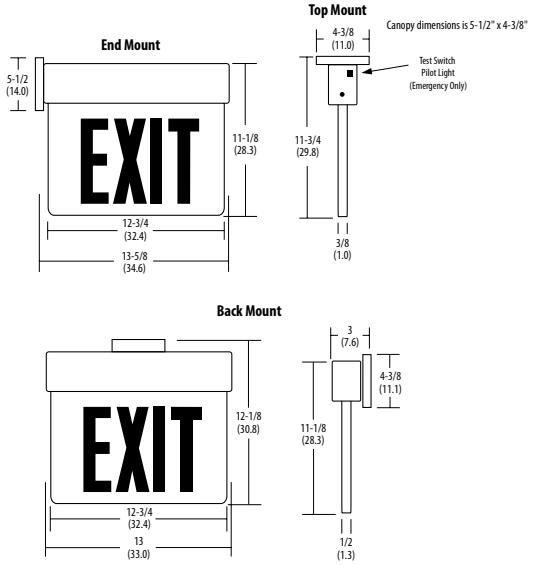
KEY FEATURES



Universal chevron indicators for field selection/installation.

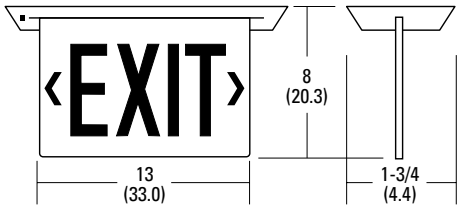
MOUNTING

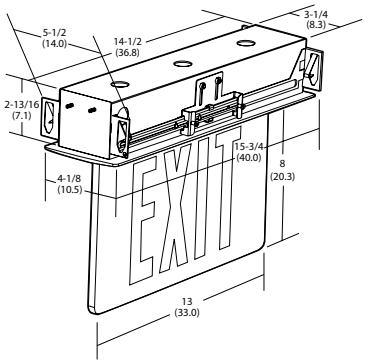
EDG



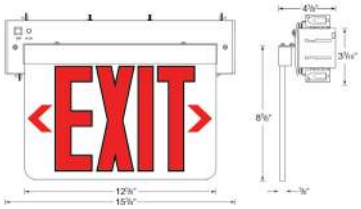
EDGR

Note: For drop ceiling applications refer to the standard installation section of the instruction sheet. Not applicable for "bracket mount" installation.





EDGR WM option



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